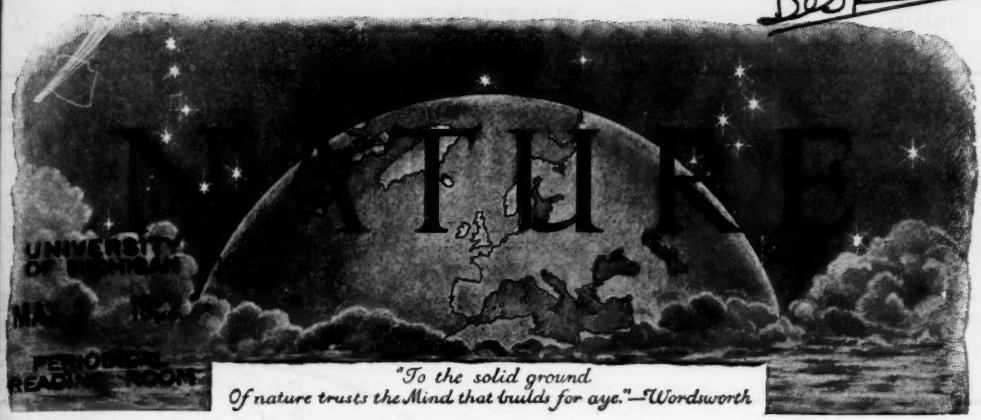
Desk


NATURE
UNIVERSITY OF MICHIGAN
PERIODICAL READING ROOM
"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 169, No. 4303 SATURDAY, APRIL 19, 1952 TWO SHILLINGS

NEW BINOCULAR MICROSCOPE
WITH BUILT-IN ILLUMINATION

THE WIDE-FIELD GREENOUGH

gives truly stereoscopic image

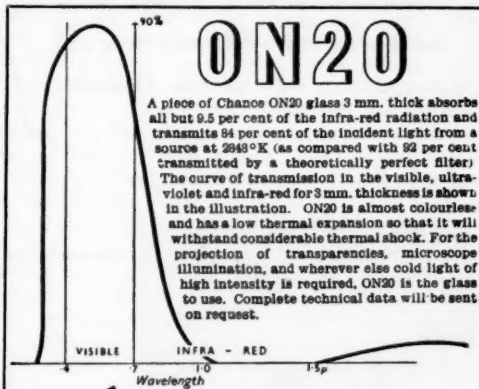
is fitted with rotating turret containing three objectives

Write for illustrated leaflet

C. Baker
(OF HOLBORN) LTD. EST. 1765

M.I. Section, 244 High Holborn, London, W.C.1
Tel.: Holborn 1427 & 4004

ON20



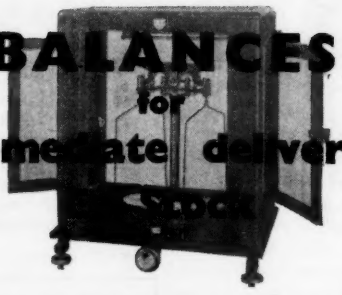
A piece of Chance ON20 glass 3 mm. thick absorbs all but 9.5 per cent of the infra-red radiation and transmits 84 per cent of the incident light from a source at 2848°K (as compared with 92 per cent transmitted by a theoretically perfect filter) The curve of transmission in the visible, ultra-violet and infra-red for 3 mm. thickness is shown in the illustration. ON20 is almost colourless and has a low thermal expansion so that it will withstand considerable thermal shock. For the projection of transparencies, microscope illumination, and wherever else cold light of high intensity is required, ON20 is the glass to use. Complete technical data will be sent on request.

A Chance PRODUCT

CHANCE BROTHERS LIMITED, Glass Works, Smethwick 40, Birmingham. Telephone: West Bromwich 1924. *LONDON OFFICE*: 28 St. James's Square, S.W.1. Telephone: WHitehall 6009. *BRANCH WORKS*: Glasgow, St. Helens and Malvern.

BTL

Various models available from stock. Aperiodic air damped, Analytical, General Laboratory, Students, Workshop, Heavy Capacity, *Full particulars sent on request*



BALANCES for immediate delivery from stock

BTL

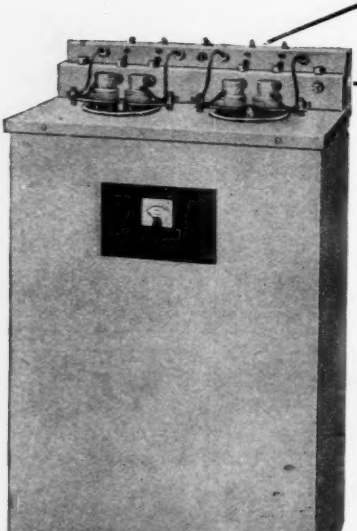
B.T.L. Balances are well-known for their design and workmanship which ensures accuracy and sensitivity combined with long and trouble-free service and durability.

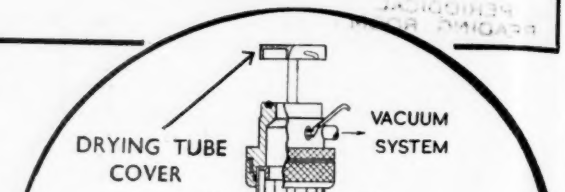
BAIRD & TATLOCK (LONDON) LTD.
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

Tissue Dehydration and Fixation

—by Freeze Drying

A new tissue dryer embodying many novel and valuable features as a result of extensive field experience and co-operation with eminent biologists.





(Inset) Diagram of Tissue Dryer drying tube.
(Left) A standard 4-drying tube unit. (2-tube unit also available.)

Prices

TD.2 (2-tube) 230 v. A.C. £228
TD.4 (4-tube 230 v. A.C. £384

Important Features

★ *Four independent drying tubes each accommodating two specimens up to 1 cm. in diameter.*

★ *Rapid drying achieved by the elimination of tortuous pumping lines.*

★ *Dry specimen wax-embedded in situ. Separate external vacuum embedding permitted by independent vacuum isolation valves.*

★ *Precision temperature control.*

★ *All-metal vacuum system incorporating modern vacuum 'plumbing' devices—no greased joints.*

for better vacuum service . . .

W. EDWARDS
& CO. (LONDON) LTD., LONDON, S.E.26
Phone: Sydenham 7026 (8 lines) Grams: Edcohivac, Souphone, London

NATURE

No. 4303 SATURDAY, APRIL 19, 1952 Vol. 169

CONTENTS

	Page
Man-power and Local Government in Britain	635
Advances in Plant Physiology. By Prof. G. E. Briggs, F.R.S.	637
The Riemann Zeta-Function. By Prof. J. M. Whittaker, F.R.S.	637
Interactions of the Fundamental Particles. By Dr. J. G. Wilson	638
Treatise on Zoology. By Prof. C. H. O'Donoghue	638
Surface Chemistry, Pure and Applied. By Prof. N. K. Adam, F.R.S.	639
Puritan Diabolism. By Dr. E. J. Dingwall	640
Excitation and Inhibition in Nerve and Muscle Fibres	642
Diseases of the Hop: Work at East Malling Research Station. By Dr. W. G. Keyworth and Dr. R. V. Harris	644
The Metabolism of Ethyl Alcohol. By Dr. Erik Jacobsen	645
Obituary: Dr. G. W. M. Findlay. By Dr. P. C. C. Garnham	648
News and Views	648
Molecular Organization in Giant Chromosomes. By E. J. Ambrose and Dr. A. R. Gopal-Ayengar	652
A War-time Fishery. By Dr. L. Harrison Matthews	653
The Origin of Astronomy	655
Geological Aspects of Clay Mineralogy. By Dr. R. C. Mackenzie	656
Food Protection in the United States	658
Origin and Distribution of Cultivated Plants in South Asia. By Prof. S. C. Harland, F.R.S.	658
Pacific Science Association	659
Letters to the Editors:	
Relativity and Indeterminacy.—H. Bondi	660
Interferometric Studies on Coals.—Prof. S. Tolansky, F.R.S.	660
Lunar Variations in F2 Region Critical Frequency at Singapore.—B. W. Osborne	661
Viscosity of Dilute Gelatin Solutions.—G. Stainsby	662
Strength of Reinforced Concrete under the Action of Combined Stresses, and the Representation of the Criterion of Failure by a Space Model.—Henry J. Cowan	663
The Colouring of Maps.—G. A. Dirac	664
A Totally Sex-linked Gene in the House Mouse.—Dr. D. S. Falconer	664
Production of Congenital Defects in the Offspring of Pregnant Mice Treated with Compound *F*.—H. Kalter and Dr. F. C. Fraser	665
Luminescent Responses in *Choetopterus* and the Effects of Eserine.—J. A. Colin Nicol	665
Delayed Toxicity of Certain Trypanocidal Drugs in East African Zebu Cattle.—M. L. Burdin and W. Plowright	666
Preliminary Observations on a Repellent for Terrestrial Leeches.—Lieut.-Col. Robert Traub, Major Charles L. Wisseman, jun., and Dr. J. R. Audy	667
Feeding Value to Poultry of Grass Leaf Protein.—Dudley E. Eyles	668
Egg Production of Pullets Fed on a Ration containing Aureomycin.—Dr. K. J. Carpenter and Dr. J. Duckworth	669
Influence of Crushing on the pH of Grass Silage.—Dr. A. J. Barnett	669
β-Glucuronidase Activity of Peripheral Nerve during Wallerian Degeneration.—D. M. Hollinger, J. E. Logan, W. A. Mannell and Prof. R. J. Rossiter	670
Application of Paper Chromatography to the Study of the Transaminase System.—P. G. Tulpule and V. N. Patwardhan	671
A Simple Application Technique for Paper Chromatography.—L. Novellie	672
Bimolecular Nucleophilic Substitution with Anionotropic Rearrangement.—Dr. P. B. D. de la Mare, Prof. E. D. Hughes, F.R.S., and C. A. Vernon	672
Isomerism of Planar Binuclear Co-ordination Complexes.—Dr. J. Chatt and F. A. Hart	673
Minimum Infiltration-Rates to Underground of Rain-water in South Africa.—Dr. V. L. Bosazza	674

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
The annual subscription rate is £6 0 0, payable in advance, Inland or Abroad.
Advertisements only should be addressed to:
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.
Telephone Number: Temple Bar 1942

All rights reserved. Registered as a Newspaper at the General Post Office.

MAN-POWER AND LOCAL GOVERNMENT IN BRITAIN

THE second report of the Local Government Manpower Committee*, which appears at a time when the need for economy in man-power is even more acute than when its first report appeared in December 1949, is concerned mainly with reviewing and co-ordinating the existing arrangements for ensuring economy in the use of man-power by local authorities and by those government departments which are concerned with local government control. In the first report the Committee had concentrated its attention on the possibility of relaxing departmental supervision of local authority activities and delegating more responsibility to local authorities. Recognizing that local authorities are responsible bodies competent to discharge their own functions and that they exercise their responsibilities in their own right, the Committee recommended revised arrangements over a wide field, representing a considerable simplification and loosening of departmental control. To the present report there are appended several reports dealing with the relations between central and local government. These include one by a sub-committee of the Ministry of Education, which details the principles of control suggested and the ministerial duties which entail control; two reports from the Local Government Services panel dealing with procedure for land transactions and compulsory purchase orders; one on the control of building resources; another on the appointment and dismissal of medical officers of health and sanitary inspectors; and papers from the local government side and the departmental side on the use of the 'district valuer'.

The Committee believes that it has now taken this work as far as it usefully can at present, and one of the appendixes lists the recommendations which involve legislation. Departments have already brought other recommendations into force, and the Committee considers that its most important task has been its general examination of the methods of procedure used in central and local government. With regard to central government procedure, it reiterates the general principle that the objective should be to leave as much as possible of the detailed management of a scheme or service to the local authority, and to concentrate departmental control at the key points where it can most effectively discharge its responsibilities for government policy and financial administration. This principle is not wholly observed, and its general adoption is calculated to promote both economy in man-power and vitality in local government. Some improvement in inter-departmental co-ordination is also possible, though the problem is not simple, and no single remedy has been found. The Committee also thinks it desirable that the Ministry of Housing and Local Government should take the lead in reviewing, from time to time, in consultation with other ministries, those aspects

* Second Report of the Local Government Manpower Committee. (Cmd. 8421.) Pp. ii+54. (London: H.M. Stationery Office, 1951.) 1s. 6d. net.

of government organization which directly affect local authorities.

On the local government side, stringent requirements about council approval of expenditure cause great waste of time in local government. Such requirements should be modified, and the Committee directs attention to the importance of establishing a proper distinction between the formulation and the application of policy.

As already indicated, the Committee believes it has now completed its main task and is satisfied that its recommendations have already substantially reduced the work required of the staff of local authorities and of government departments, although it gives no estimate of the consequent considerable savings in man-power. It appears to have passed, however, rather too summarily over the question of regional administration. A paper on the regional organization of government departments is indeed appended to the report, and the Committee in general concedes the force of the local government representatives' point of view that either more power should be given to regional organizations or that they should be abolished. It seems clear that regional administration must either be improved or in part discarded, and the Committee's reluctance to formulate anything more formal in the way of a recommendation than the opinion that the utility and delegated powers of regional organizations need frequent review, may be due to the way in which the problem is linked with those larger issues outside its terms of reference with which the Local Government Boundary Commission was confronted.

The question of economy in local government manpower cannot, in fact, be dissociated from that of the efficiency of local government institutions in general. The Local Government Boundary Commission was convinced that effective and convenient units of local government could not be created without some amendment of local government legislation. Since the Commission was dissolved in 1949, the policy of drift has continued. Both major political parties have hitherto burked at any attempt to reconstruct local government bodies, and piecemeal alterations in their responsibilities have continued to weaken them and to distort their structure, so that they are less and less able to discharge their responsibilities effectively, or to attract to their service men and women of the calibre that is desirable.

The issue of regionalism has been avoided in one form by the central Government, but the alternative—a recasting, on some general plan, of the outmoded structure of local government—cannot be postponed indefinitely without disaster. Something much deeper than tinkering with man-power in local government is required, to ensure both that the nation's resources in men and women are wisely and efficiently used, and that the process of administrative centralization, which has robbed local government of its traditional virility and independence and its capacity to attract public-spirited men and women to its service, is arrested. The coincidence of the imposition of higher standards of service by government departments with economic stringencies has bound local government far too tightly to Whitehall; and they cannot well be released by the measures, however admirable in themselves, which are adumbrated in this report.

The effect of this situation on the health and vitality of democratic institutions is likely to be more serious than is generally realized, unless the new Minister of Housing and Local Government gives a good deal of attention to the problem. What is primarily required is hard thinking and, when a reasonable solution has been thought out, the determination to carry through the necessary legislative and executive action, no matter what sectional pressure or prejudice may have to be overcome. It is a matter in which the national interest should override all those political and partisan interests which have hitherto prevented any attempt to grapple effectively with the situation.

Fortunately, the position is not yet irretrievable. A report from the National Association of Local Government Officers—on the scope for enterprise in local government—recently indicated the great opportunities for initiative and experiment which welfare work, such as the care of special groups like the disabled and aged, offers to local authorities. Preventive health services, community centres, home helps—all these are ways in which, given vision and enterprise, local government might find new opportunities and regain vitality while attracting to its service not merely the highest type of professional worker but also the voluntary worker. Even the exigencies arising out of cuts in educational and other estimates might offer opportunities of this type.

However great the imagination and energy of local authorities, there are two limiting factors beyond their control. One is finance, and the other is that of local government areas and functions. Recommendations in this report on local government manpower go some way to avoid the waste of man-power in unnecessary types of accounting; but more is needed if the local authorities, with their increasing dependence on the central government for financial support, are to be capable of continuous and independent planning. Something in the nature of block grants over a period of years may be required for certain purposes, and it may even be desirable to discriminate between different local authorities in the extent to which central control is imposed.

This can, however, scarcely be done without facing fairly and squarely the issue of areas and functions, as it was fairly stated by the Local Government Boundary Commission, and which has hitherto been shelved by government in spite of pledges given by both political parties. On the importance of the place of local government in the national life of Britain there is general agreement, and if agreement as to its purpose is less common, a determined lead by the Government to preserve and strengthen what remains of local self-government should command enough support for any necessary legislation. It might involve accepting variations in local services and costs, but the obvious defects of the system are generally recognized and could be remedied by agreement. A comprehensive reform may well be

the only reasonable course, as the Local Government Boundary Commission recognized; but apart from the effect of the decay of the minor local authorities when resources are too limited for them to form efficient units for modern services, the claims of many large towns for boundary extensions cannot in equity be longer ignored. Debates in the last Parliament demonstrated the alarm with which the situation was regarded by members of all parties. Mr. Harold Macmillan's statement in the House of Commons that he hoped to present some measure of local government reform in the course of the present Parliament will be warmly welcomed. He insisted, however, that without substantial agreement between the interests concerned there is no prospect of introducing such a measure even in 1953. A determined attempt to reach agreement on the subject is worth making at the present time. If it succeeded, it would be of real national benefit, and its short-term effects might even ease the present strain on man-power to some extent, apart altogether from the long-term effects on the vitality of democratic institutions.

ADVANCES IN PLANT PHYSIOLOGY

Annual Review of Plant Physiology
Daniel I. Arnon (editor), Leonard Machlis (associate editor). Vol. 2. Pp. x+361. (Stanford, Calif.: Annual Reviews, Inc., 1951.) 6 dollars.

AN examination of the present volume raises the question as to what are the aims of such a publication. The preface to the series appearing in the first volume mentions "knitting closer ties between physiologists active in agricultural specialties and those engaged in fundamental research"; "service in teaching at advanced level"; and "critical evaluation of results rather than encyclopedic completeness".

In this volume there are nearly nineteen hundred literature citations—an average of nearly six per page of text. The longest article has the lowest average of a little more than two while the shortest has the highest of about twenty-four per page. Has the question of the necessity of all these citations been considered? It would be invidious to pick out particular contributors; but some passages are little more than catalogues of publications.

While some of the articles might well be of service for teaching at an advanced level and might have meaning for the authors of other articles in this volume, others can mean little to any but the extreme specialist. A specialist on photosynthesis can easily grasp the contents of the article on experimental morphogenesis in vascular plants and see that many physiological problems arise; but are there physiologists, except those who have kept up to date in the subject, who would gain much light from the articles on the kinetics and chemistry of photosynthesis and on the physical background of photosynthesis? It is doubtful if one "active in agricultural specialties" would find time to acquire the background of knowledge to appreciate such articles. To say this is not to pass judgment on the articles, but to raise the question as to whether a volume in this series is the right place for such reviews. One danger of such articles written by persons of great authority in special fields is that they may mislead the uninitiated when they refer to other matters. To add to Warburg's laurels by stating that his work of 1919 was "pioneer work in this field" of "the influence of external conditions on photosynthetic rate" is to give less credit than Warburg himself gave to the real pioneers.

Limitations of space and competence of the reviewer make it impossible to give an appraisal of each of the thirteen contributions; but some of the chapters, because of their exceptional nature, call for special comment. The inclusion of an article on a topic such as experimental morphogenesis in a review of plant physiology is welcomed. It directs the attention of the physiologist to problems awaiting solution and should remind him that plant physiology is a branch of botanical biology. The article on permeability, apart from a few references to yeast, makes only one reference to plants. The possibility that vacuolated plant cells may pose quite different problems from those faced by students of muscle and nerve might have been considered in an article in a book on plant physiology. This article finishes on a philosophical level, for it says "this point of view is more interesting to the physiologist since a substance entering the cell through a hole seems quite uninspiring". One wonders whether a physicist would be inspired.

This volume gives the impression of being the unco-ordinated efforts of a team of experts, some of them writing with the editorial aims in mind and others writing for their fellow experts and at times falling to the level of a briefly annotated catalogue.

G. E. BRIGGS

THE RIEMANN ZETA-FUNCTION

The Theory of the Riemann Zeta-Function
By Prof. E. C. Titchmarsh. Pp. vii+346. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 40*s*. net.

PROF. E. C. TITCHMARSH'S well-known tract on the Riemann zeta-function was written some twenty years ago. It is now out of print and, according to its author, out of date: the present book has been written to replace it. How then has the situation changed in the meantime? Not a great deal. The twenty-year period 1910–30 had been the heroic age in the theory of the zeta-function. Hardy had proved that an infinity of zeros lie on the critical line and, with Littlewood, had improved this to $N(T) > AT$. The same authors had found the approximate functional equation and the square mean value theorem which follows from it. Ingham and Titchmarsh had found mean value theorems of the fourth and higher orders. Weyl, Hardy and Littlewood and Van der Corput had discovered ways of dealing with exponential sums, and Bohr, Landau and others had brought Dirichlet's and Kronecker's theorems to bear. But each fresh discovery seemed at the same time to disclose new difficulties which made the goal seem even farther away. The better the behaviour of the zeta-function was understood, the more hopeless did it appear to understand it completely, and there seemed to be a danger that the advance would get bogged down in a morass of exponential sums.

To a large extent this has happened. In the past twenty years there has been only one really striking advance—Selberg's proof that at least a finite proportion of the zeros lie on the critical line—and even this falls far short of Riemann's, or even Lindelöf's hypothesis. But is Riemann's hypothesis true? Twenty years ago it was generally believed that it was. Now doubts have crept in. Functions are known which have functional equations and many other properties similar to those of the zeta-function, but for which the analogue of the Riemann hypothesis is false. Very powerful methods of computation are now available, and Riemann's guess may possibly be disproved in this way.

There is a chapter on Vinogradoff's method of treating exponential sums. This has had great triumphs in number theory, but so far the applications of it to the theory of the zeta-function have not been of comparable importance.

Prof. Titchmarsh treats his subject with his accustomed mastery, and his new book will be a necessity for all who seek to do research in number theory, as it contains the only adequate account of exponential sums. But in other respects it does not quite take the place of his Cambridge tract. This latter presented the main theorems of the subject in a very attractive way in less than a hundred pages and was an ideal approach to the subject. Another twenty pages would have sufficed to bring it up to date. Yet the present work is nearly three times the resultant length. The treatment is perhaps too thorough, and it cannot be denied that the book has a somewhat forbidding aspect. But then so have most mathematical books nowadays. The young are brought up to expect it.

J. M. Whittaker

INTERACTIONS OF THE FUNDAMENTAL PARTICLES

Elementary Particles

By Enrico Fermi. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. xii+110. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1951.) 12*s.* 6*d.* net.

THE data necessary before a coherent account of the elementary particles of Nature can even be attempted did not exist until the discovery, in 1947, of the π-meson (or, following Prof. E. Fermi, the "pion"). Five years later the experimental physicist, at least, has turned the spearhead of his investigations towards the more elusive members of the family, and already some of these, the V-, κ-, τ- particles, have become moderately familiar. In the course of this rapid advance, the position of theoreticians is less enviable. For, so long as they are dependent upon the results of experiments for a description of the particles which are the units with which they must work, they work in the near-certainty that the material given them is incomplete: nothing is more striking in the history of elementary particle physics during the past few years than the way in which the particles that have been discovered are those which our leading techniques are best adapted to discover, and speculation is continually being made as to how, rather than whether, further elementary particles will be identified.

In this short book, based on the Silliman Memorial Lectures at Yale University for the year 1950, Prof. Fermi is more concerned to sketch, at a level which will be intelligible to a fairly large body of physicists, the broad application of field theory to problems involving massive field particles, the mesons, than to comment on the tentative conclusions which might be drawn at the moment of writing from rapidly developing material.

"Elementary Particles" begins with an admirable summary of the quantization of the electromagnetic field and of the absorption and emission of photons, which serves as a model against which is sketched the equivalent theory for quanta with mass. This leads to the general problem of interactions and to the Yukawa-type interaction of meson theory. It is here that the real difficulty of maintaining the perspective of the approximate treatment which is followed throughout, against the uncertainties and divergences of the more complete analysis, assumes importance, and it is a great merit of the book, even if it is only what we have come to expect of its author, that the value of the "order of magnitude" estimates in this section, and in those which follow, is so clearly apparent.

In the following sections the interaction constants and transition-rates for π–μ decay, β decay, μ–e decay and μ^- capture are derived. Here, the summary of β-decay (p. 39) is perhaps the least successful, for the treatment is condensed to the point when it is likely to help only those to whom the main lines of the problem are known in considerable detail. The second half of the book covers rather less familiar ground, dealing with the production of π-mesons in nucleon collisions and by γ-rays, using normal methods, and giving a brief outline of the statistical approach to meson formation, including multiple production, in nucleon encounters at very high energy. The status of antinucleons and their annihilation properties are also considered in a short but effective section.

This is a book which will date only slowly until the critical developments of meson field-theory come. Until then—and so, perhaps, for quite a long time—it will offer an admirable introduction, for workers in nuclear physics and cosmic-ray physics, to the general methods of approach to the interaction problems of the fundamental particles.

J. G. Wilson

TREATISE ON ZOOLOGY

Traité de Zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 10: Insectes supérieurs et hemipteroïdes. Fascicule 1. Pp. ix+978. 6500 francs. Fascicule 2. Pp. iv+974–1948. 6500 francs. (Paris: Masson et Cie., 1951.)

IT is a pleasure in these times of general austerity to handle such well-produced books as those here under review, and it is not simply that they appear good in contrast with many contemporary publications but that they stand comparison with any similar works produced in this century. Perhaps it would have been better if, from the commencement of the series, a much darker binding had been chosen, for the pale creamy white, suggesting vellum, while pleasing in appearance, soon becomes soiled, and the tables and benches on which they are used in laboratories are far from immaculate.

The present volume, No. 10 in the series but the fifth to appear, is in two fascicules each of which is of approximately the same size as the previous volumes (see *Nature*, 166, 1086; 1950). The two fascicules contain 1,870 pages of text, and a very full table of contents and index occupying 78 pages. The volume is most profusely illustrated by six excellent coloured plates and 1,648 text figures. Of the plates, three are devoted to Lepidoptera including caterpillars and chrysalides and one each to Diptera, Hymenoptera and Hemiptera Heteroptera, and the examples are chosen not with regard to their bizarre form or brilliant coloration but to illustrate diverse forms or types of structure. To state that there are 1,648 text-figures, seventy in half-tone and the remainder in line, does not do justice to the wealth of illustration, since most of them contain more than one figure, and indeed thirty-five occupy full pages with a considerable number of drawings on each. All the illustrations reach a high standard of technical excellence. One that will interest many readers is the new one of the four-winged variety of *Drosophila melanogaster* (Fig. 458), which is utilized to show the homology of the halteres with the posterior pair of wings in tetrapterous insects. I should have liked to have seen a figure of the larva of *Microdon*, since it is a most puzzling creature to meet for the first time and is so unlike an insect larva that it has actually been referred to two different genera of slug-like molluscs. There is a curious omission of the left eye in the illustration of the striking larva of *Asmylops pallidus*, whereas it is present in the black-and-gold inset used as a decoration for the cover.

The groups treated include Neuroptera, Mecoptera, Trichoptera, Lepidoptera, Diptera, Siphonaptera, Hymenoptera, Mallophaga, Anopleura, Hemiptera and Thysanoptera, so that, together with those in the previously published volume, No. 9, they cover the particular anatomy, systematics and biology of the insects. There is yet another volume, 8, to appear which will be concerned with the general problems of anatomy, physiology and reproduction before the insects have been adequately covered. The appearance of this volume is looked forward to, since it will complete the most comprehensive account of the class that has been available to the general zoologist for many years. As in previous volumes, a number of authorities from different institutions or places have contributed to its contents. They are: A. Eadonnel, L. Berland, J. Bourgogne, R. Jeannel, P. Pesson and the director of the whole work, Pierre-P. Grassé, all of Paris; F. Bernard, of Algiers; R. Poisson, of Rennes; and R. Despais, of Toulouse.

It is difficult to formulate any general criticism of this most acceptable work, and it is out of place in a general review to pick on points of detail unless illustrative of tendencies. I feel, however, that so much attention in zoology is focused on the chromosome mechanism nowadays that more space might have been devoted to it. It is true that it is referred to in some groups, and its relationship to gynandromorphism, sex-determination, parthenogenesis, etc., is very briefly dealt with. On p. 278 attention is directed to the wide range of variation in chromosome number exhibited by the Lepidoptera, where the haploid number ranges from 8 to 118 and considerable variation may occur within the genus. Quite frequently, not invariably, in the section dealing with Diptera an indication of the magnification is provided, and it is a pity that this practice is not more uniformly adopted.

This book is a worthy addition to the previous excellent volumes; and the director, authors and publishers have put general zoologists everywhere in their debt, for these are volumes one cannot be without.

C. H. O'Donoghue

SURFACE CHEMISTRY, PURE AND APPLIED

Surface Activity

The Physical Chemistry, Technical Applications and Chemical Constitution of Synthetic Surface-Active Agents. By Dr. J. L. Moilliet and Dr. B. Collie. (Industrial Chemistry Series.) Pp. x+379. (London: E. and F. N. Spon, Ltd., 1951.) 55*s*. net.

The Surface Chemistry of Solids

By Dr. S. J. Gregg. Pp. ix+297. (London: Chapman and Hall, Ltd., 1951.) 30*s*. net.

Surface Chemistry

An Introduction to its Principles and Applications. By Dr. A. E. Alexander. Pp. vii+70. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 7*s*. 6*d*. net.

DRS. J. L. MOILLIET and B. Collie are very well qualified, both by their own contributions to surface chemistry, and by many years of experience in industry, to write about surface-active agents and their many technical applications; and in their book on "Surface Activity" they have carried out their task extremely well. It is in three parts. The first contains two chapters on the physical chemistry of surface agents: one on their state in solution, and the other on the thermodynamics and kinetics of adsorption. These will not be found easy except by readers very well grounded in physical chemistry; but the treatment is very full and up to date, including critical accounts of views as to the shape and structure of the ionic micelle, and of the puzzling very slow adsorption sometimes found; the two chapters are probably the best account of these topics which has yet appeared. There follows a very interesting chapter on fundamental interfacial processes dealing with the various forms of wetting, emulsification, and dispersion of solids in liquids; there is also some discussion of precipitation and the effect of surface-active agents on crystal growth. This chapter is largely original and most valuable.

In the second part, many technical applications are described, the emphasis being more on scientific principles than descriptions of plant. Among the more interesting sections are a discussion of the conditions under which the droplets in a spray adhere to, or bounce off, a solid surface; an account of velanization, and similar processes in which cellulose surfaces are rendered durably water-repellent by first coating them with a long-chain pyridinium compound, and then decomposing this adsorbed layer so that the long chains become bound by ether linkages to the hydroxyl groups of the cellulose; and a careful analysis of the factors in detergent action. In the last part of the book an excellent account is given of the organic chemistry of the principal surface-active agents, and of the methods for their preparation.

This book is very carefully thought out everywhere, and abounds in novel points of view; it is far in advance of some recent compilations which seem little more than repetitions of elementary surface

chemistry, with lists of technical surface-active agents. It should not only be read, but also repeatedly studied, by all interested in the modern theory and applications of surface activity.

Dr. S. J. Gregg's book, "The Surface Chemistry of Solids", is disappointing. It has fifteen chapters, including one on surface films at liquid surfaces; but the arrangement is not systematic, nor is the theory coherently or fully developed. A good deal of the information can be found, often more thoroughly treated, in other books; this is particularly the case in the sections on adsorption, films on liquids, and friction and lubrication. Nevertheless, the author does discuss a number of topics generally neglected by writers on surface chemistry; among these are Bangham's theory of the structure of films adsorbed on charcoal, Hüttig's work on sintering, and some recent work on contact catalysis; there is also interesting information on dusts in a chapter bearing the curious title of "The External Surface of a Solid". Mathematical theory is generally omitted, though some few unproved formulæ are quoted. The book is nowhere really thorough and contributes little substantial to existing theory; but it should direct attention to some, though far from all, of the recent work not yet incorporated in other books.

In the short space of the seventy small pages of his book "Surface Chemistry", Prof. A. E. Alexander succeeds in giving an introduction to surface chemistry for the general scientific reader which is not only readable but manages to impart a very large amount of information. No previous knowledge of the subject is assumed; yet the essentials of such topics as the structure of surface films on liquids and solids, the nature and measurement of surface tension, foaming, emulsification, spreading, electrocapillarity and electrokinetic phenomena are all very clearly explained. Even the historical development is adequately indicated, and there are many well-chosen references to technical and some to biological applications. The illustrations are numerous, and very clear. This booklet can be warmly recommended to biologists and all who desire a thoroughly sound, comprehensive, yet easy introduction to surface chemistry.

N. K. Adam

PURITAN DIABOLISM

The Devil in Massachusetts

A Modern Enquiry into the Salem Witch Trials. By Marion L. Starkey. Pp. 269+9 plates. (London: Robert Hale, Ltd., 1952.) 18*s*. net.

THIS volume, which was first published in New York in 1949, is another contribution to the literature concerning the Salem witchcraft delusion of 1692–93. Written in an easy, popular style, it tells the story of the extraordinary events in Massachusetts, in words which have been largely taken from the original documents, and attempts to sum up the facts from both the contemporary angle and from that of more modern times.

The narrative begins with an account of the hysterical attacks of some of the girls in the village, and shows how their point of origin may perhaps be seen in the intimacy between the afflicted and old Tituba, the Rev. Samuel Parris's Negro slave, who told the girls of magical ceremonies and possiby taught them a few simple tricks and charms. The first hysterical outbreak occurred with little Betty Parris, then nine years old, and with her cousin, the eleven-year old Abigail Williams, both youthful members of Parris's household in Salem Village.

The attacks began in the usual way. At first the girls seemed absent-minded or broke into uncontrollable fits of weeping. Gradually their behaviour became more unrestrained. They would make babbling or barking noises, crawl about on all fours, rolling their eyes and twisting their limbs while writhing on the floor. Such phenomena were not new. They were as old as witchcraft itself and were believed to be clearly the marks of diabolic interference, which, as every Christian knew, was as certain and sure as the sacred character of Holy Writ which proclaimed it. Thus, when the girls, soon to be joined by others in genuine or simulated attacks, began to "cry out" on those who were supposed to afflict them, declaring that their persecutors were witches, their statements, instead of being treated as symptoms of hysteria, were regarded with the utmost seriousness, and their tales of persecution by the apparitions or "shapes" of those denounced were regarded as good evidence for the truth of their assertions generally.

In developing her story, Miss Starkey is commendably judicial in her approach, and it is somewhat to be regretted that she has not seen fit to expand her theme in greater detail. She points out that the epidemic and the subsequent hangings were part of the social and economic conditions of the times. Although the theocracy was already cracking, orthodox belief in hell and the devil was still sufficiently strong to support the theories of witchcraft. However, even then some dissentient voices dared to make themselves heard and some muttered about giving the girls a good whipping; others went so far as to say that what some of the older wenches needed was a man, a suggestion which was shown to have some substance in view of the later activities of the afflicted damsels.

The fact was that, with the gradual decline of the earlier religious fervour and the slow growth of prosperity, the young women were beginning to suffer that frustration and sense of guilt inseparable from the kind of lives they lived. The temptation was irresistible. From being nobodies they suddenly became leading members of their community with actual powers of life and death over prominent citizens of hitherto irreproachable character. Life, from being a humdrum round of domestic chores, became exciting. As one of the girls bluntly confessed, when accused of lying by some sceptics: "It was for sport. I must have some sport".

Compared with the history of other witchcraft epidemics, that at Salem Village can be regarded in a light very favourable to many of the participants, although the author of this book does not hesitate to condemn where condemnation is due. What is clear is that, with the end of the delusion and the realization of the errors committed in hanging the innocent, came also another step towards the weakening of belief in the supernatural and thus a further breach in the theocratic structure.

As a simple and well-arranged account of the Salem calamity, this book can be recommended, although Miss Starkey, had she been better prepared, might have considerably amplified the psychological discussion. With an excellent bibliography and index the book is a notable contribution to writings on witchcraft, and throws a vivid light on one of the most interesting events in the early history of Massachusetts.

E. J. Dingwall

Tensor Analysis for Physicists

By Prof. J. A. Schouten. Pp. x+276. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 30*s*. net.

THIS great work by Prof. J. A. Schouten will be welcomed as a modern exposition of a subject which he has already treated in his classical monograph, "Der Ricci-Kalkül", published in 1924 by Springer. It also incorporates the work which he published in collaboration with Struik in 1935 and 1938, entitled "Einführung in die neueren Methoden der Differential-Geometrie: I, II".

The subject is expounded in a monumental manner, and the physicist will find that he is compelled to observe the full rigour of the game. The treatment is full and exhaustive: Schouten's theory of a "geometric object" is given in full, and the tensor analysis is throughout made subservient to the theory of linear groups. The second half of the book is devoted to physical applications of the theory, and it includes the theory of elasticity, classical dynamics, relativity, and Dirac's matrix calculus. There is probably no other book which covers the same ground in such extent and in such detail. It will be indispensable to the mathematical physicist for many years to come, but he will probably use it as a work of reference rather than as an introduction to the subject. Even the convenient summary of the first five chapters, which is given by the author because it "was specially asked for by physicists", presents a very forbidding aspect to those who have learnt their tensor calculus in order to study the special and general theories of relativity.

However, there is no doubt that the work richly repays detailed study, and both physicists and mathematicians are greatly indebted to the author for giving them the fruits of a lifetime's meditation on this important mathematical technique.

Mechanical Vibrations

By Prof. William Tyrrell Thomson. Pp. viii+222. (London: George Allen and Unwin, Ltd., 1950.) 15*s*. net.

The Theory of Vibrations

For Engineers. By E. B. Cole. Second revised edition. Pp. 334. (London: Crosby Lockwood and Son, Ltd., 1950.) 18*s*. net.

PROF. W. T. Thomson's book contains a clear account of vibration theory. The first four chapters cover the free and forced vibration of systems having one degree of freedom. These chapters will provide the third-year honours engineering student with all the material that he requires on this subject, an elementary knowledge of the calculus and differential equations, including the use of the j operator, being assumed. The later chapters cover more advanced work, including the differential equations for elastic-body vibration, and various methods for the calculation of the frequencies of complicated systems, such as iteration and Myklestadt's process. These chapters will be most valuable for the student who wishes to specialize. The treatment throughout the book is sound and lucid, and the diagrams are good. A large number of examples are included.

Mr. E. B. Cole's book is designed for those with less mathematical knowledge. It has been very considerably enlarged since the first edition appeared in 1935. It begins with an explanation of simple harmonic motions and the use of rotating vectors. The later chapters cover the calculation of torsional vibration frequencies in engines, the whirling speeds of shafts and the flexural vibration of beams. It will be of use to those who need frequency calculations in design work. Many of the examples quoted are of practical interest; a number of references to papers are included at appropriate places in the text.

D. C. JOHNSON

Man and Matter

Essays Scientific and Christian. By Dr. F. Sherwood Taylor. Pp. 238. (London: Chapman and Hall, Ltd., 1951.) 15*s*. net.

MOST of these essays are biographical in the sense that the author is defining and defending his position as a student of science and a Roman Catholic. The first is explicitly so; describing how he reacted against the formalistic religion of his home and school, took up science as a career along with the positivist creed which seemed to go with it, discovered that half his nature was unsatisfied, and after going far afield to oriental mysticism for what he wanted found it nearer home. Out of this devious inquiry comes one of the most interesting of his essays, "Mysticism, Christian and Pagan". The titles, "The Deficiencies of Materialism"; "Science, Philosophy and Religion"; "Biology and Man"; "Evolution and Religion"; "The Vocation of Science"; "The Church and Science", indicate the scope of Dr. Sherwood Taylor's exposition. The essay on "The Problem of Pain in Nature" is too slight to do justice to one of the knottiest of all problems. On the other hand, the one "On the Excellence of Things" explains, with apt quotations from Western poets and Chinese sages, just what scientific men tend to forget. The essay on "Some Moral Problems Raised by Science" makes the point that positivists frequently claim that natural science could provide answers to moral questions out of its own resources, but fail to show how it can be done in any specific case. "The Place of Science in Christian Education" is to be commended, specially for its criticism of the artificiality and abstractness of a great deal of actual teaching.

A. D. R.

The Faith of a Fieldsman

By H. J. Massingham. Pp. 271+17 plates. (London: Museum Press, Ltd., 1951.) 15*s*. net.

H. J. MASSINGHAM has long been known as a writer on life in the countryside. In his latest book, "The Faith of a Fieldsman", he returns to this well loved theme, his pen roving over a wide variety of topics concerning the land, particularly English land, and those whose lot it is to tend it and live on it. In short, chatty chapters, he discusses this and that, dividing his subject matter into sections, "Country Life and Culture", "The Farming Scene", and so on, the last section being devoted to "A Few Verses". Mr. Massingham sees much virtue in many things, things that are passing with the changing times, such as the old village craftsmen and goodly hedges between the fields, and correspondingly little virtue in the doings of this mechanized generation. Those of us who likewise love the old English countryside will enjoy his gibes and shrewd thrusts, even if at the same time we recognize that change is the essence of life, and even the slow-to-move communities of village and farm are not immune from the trend of the times, which indeed must be the case if they are to survive in any form, whether in their old or some new shape.

FRANCES PITT

EXCITATION AND INHIBITION IN NERVE AND MUSCLE FIBRES

A FULL-DAY symposium on "Excitation and Inhibition" was held at the Royal Society on February 21, with the president, Prof. E. D. Adrian, in the chair. In opening the symposium, Prof. J. C. Eccles (Canberra) stated that there is general agreement that the properties of the surface membranes of nerve and muscle fibres are of fundamental importance in providing the data that are essential for understanding the excitatory and inhibitory processes at junctional regions, for example, at neuro-muscular and synaptic junctions. He said that there had been a rapid advance in knowledge in the whole field, and hence it was opportune to have this discussion in order to attempt a correlation of the various advances.

Prof. A. L. Hodgkin (Cambridge) described experiments done in collaboration with A. F. Huxley on the giant nerve fibres of squid and *Sepia*, which are particularly suitable for investigation of the properties of surface membranes during rest and activity. The surface membrane separates the internal axoplasm (with high potassium, and low chloride and sodium) from the external fluid (with high sodium and chloride, and low potassium). Investigation with radioactive tracers has shown that during the propagation of an impulse there is a net inward flux across the membrane of about 4 $\mu\mu$mol./cm.^{2} of sodium and a net outward flux of about the same amount of potassium. The experimental investigation was designed to measure precisely the time courses of the sodium and potassium fluxes and hence to provide an explanation for the action potential of the propagated impulse.

Essentially, by means of an electronic feed-back device, the potential across a long length of membrane can be 'clamped' at any predetermined voltage by means of current supplied between a central core electrode and an external cylindrical and coaxial encasing electrode. After an initial very brief capacitative current, the time course of the applied current will exactly equal the flow of the net ionic current across the membrane. When the voltage across the membrane is suddenly reduced, there is an initial inward current for about two milliseconds, which is shown to be due to an inward flux of sodium ions because it varies with the concentration of sodium ions in the external medium in precisely the way that would be predicted. Afterwards there is an outward current that continues throughout the application of the 'voltage clamp'. Radiotracer measurements have shown that the outward flux of potassium exactly accounts for the whole of this outward current flow. Thus, when the membrane is depolarized, there are permeability changes to both sodium and potassium ions, the former being large but transient, the latter slower but maintained.

By determining the changes in sodium and potassium permeability for all levels of voltage change in the membrane, it has been possible to give a satisfactory quantitative account of the nerve impulse—not only the time course of the rising and falling phases, but also of the conduction velocity. Furthermore, it has been possible to account quantitatively for the increase in membrane conductance during the impulse by the increases in sodium and potassium fluxes.

Prof. B. Katz (London) gave an account of an investigation (with Dr. P. Fatt) into the nature of the electrical events occurring during neuro-muscular transmission. By recording with a micro-electrode in a muscle fibre, it is possible to measure the total quantity of electricity that a nerve impulse causes to be transferred across an end-plate membrane. The quantity is surprisingly large, 8×10^{-10} coulombs for a curarized muscle fibre, 3×10^{-9} coulombs for a non-curarized fibre, and up to 10^{-7} coulombs for an eserinized non-curarized fibre. This latter value actually exceeds the total ionic charge stored in the nerve terminal. Hence neither the electrical currents produced by impulses in the nerve terminal nor ions released therefrom can directly cause the ionic flux that gives the end-plate potential. All the evidence supports the hypothesis that acetylcholine in some way acts on the end-plate membrane to make it extremely permeable to ions. There must be an enormous amplification between the relatively few acetylcholine molecules released from the nerve ending and the very large ionic flux across the end-plate membrane.

A study of the spike action potential of the end-plate region has indicated that, when acted on by acetylcholine, the end-plate membrane has such a low resistance that it virtually 'short-circuits' the muscle fibre, so depressing the spike potential. This short-circuiting effect would be adequate to account for the intense ionic flux that gives the end-plate potential. This explanation is further supported by finding that alterations in the membrane potential produced proportional alterations in the end-plate potential. Thus it is concluded that the electric response of the end-plate differs in two respects from the spike-action potential of a nerve or muscle fibre: it is induced by acetylcholine and not by an electric current; and it involves a membrane short-circuit which leads to a simple depolarization as in the Bernstein theory of the nerve impulse, in contrast to the specific increase of sodium permeability and reversed membrane potential that is now known to occur in the nerve impulse.

Prof. A. Fessard (Paris) described investigations on the problem of transmission from nerve to the electric organs of *Electrophorus* and *Torpedo*. It has usually been assumed that the transmission is very similar to that of the end-plate potential, but precise investigation has failed to find in the electric organ the double electrical response characteristic of the neuro-muscular junction, that is, end-plate potential and muscle spike potential. The only electrical response of the electric organs appears to be analogous to the muscle spike potential and, like it, is associated with a large reversal of the membrane potential. Despite extremely favourable conditions of recording, it has not been possible to detect any intermediate electrical response resembling the end-plate potential. Nevertheless, the transmission from nerve to electric organ appears to be mediated by acetylcholine; for example, an electrogenic effect is produced by injected acetylcholine. But Prof. Fessard doubted if this effect of acetylcholine normally causes the discharge of the main action potential, for it is very small in size and prolonged in duration. Yet curare blocks the transmitter action from nerve to electric organ,

and anticholinesterases prolong the electrical response. The special conditions that are found with different electrical organs were strikingly illustrated by the finding of Albe, Fessard and Chargas that in *Electrophorus* the electrical plates are directly excited by electrical stimulation even when curarized, while no such effect occurs with *Torpedo*. With *Electrophorus* the electrical response is presumably propagated just as in nerve or muscle fibres. In conclusion, Prof. Fessard warned against too simple an interpretation of the problems of junctional transmission in electric organs. There appear to be several distinct types of organ, and much more histological, electrical and pharmacological investigation is necessary in order even to define the problems.

The principal theme of the contribution by Dr. R. Lorente de Nó (New York) was that medullated nerve is very different in its properties from giant nerve fibres. Though sodium likewise plays an important part in the functioning of the medullated nerve fibre, he brought forward evidence in support of the hypothesis that it is not directly concerned as in non-medullated fibres, but acts secondarily by aiding in the synthesis of some substance which is essentially concerned in the propagation of impulses. In this way, Dr. Lorente de Nó accounted for the slow development of inexcitability when nerves are subjected to a sodium-free medium, and the partial and reversible recovery of excitability that occurs when an inexcitable nerve is removed from the sodium-free medium and placed in air. The inexcitability was attributed by Dr. Lorente de Nó primarily to depletion of the substance that is essential for impulse propagation. Some experimental evidence was given suggesting that this postulated substance might be an amine or a quaternary ammonium compound. Cocaine and some quaternary ammonium compounds are known to be able to act as substitute for sodium and restore excitability of some nerve fibres deprived of sodium. The crystalline chlorides of at least three quaternary ammonium bases have been isolated from ox brain, and Dr. Lorente de Nó suggested that some of these naturally occurring bases might be the essential substances concerned in the propagation of nerve impulses in medullated nerve fibres.

Prof. R. Granit (Stockholm) gave a historical survey of the complex field of retinal action potentials and their relationship to the excitatory and inhibitory processes that are revealed by the discharge of impulses in the optic nerve. Light induces in the retina two major electrical responses, *P* II and *P* III, which are of opposite electrical sign. Much experimental evidence was presented to show that *P* III is of opposite sign, because it represents an opposite process and not because it is a similar process in a structure of opposite orientation. Thus twenty years ago analysis of retinal action potentials gave one of the first clues that excitatory and inhibitory processes are attributable to opposite states of polarization of nerve cells. Though complex in structure, the retina has the advantage that the component nerve cells are regularly orientated, and hence it produces even with external leads large potential changes that can be effectively analysed. In conclusion, Prof. Granit directed attention to the significance of these observations in relation to the recent experimental evidence by Brock, Coombs and Eccles that excitation and inhibition of motoneurones in the spinal cord are associated respectively with the opposite electrical reactions of depolarization and hyperpolarization. Thus in the retina, as in the spinal cord, there is depolarization of excited neurones and hyperpolarization of inhibited neurones.

Dr. W. Feldberg (London) appropriately spoke on the general problem of chemical transmission, with special reference to the way in which excitatory and inhibitory effects can be exerted on the same cell. He first considered three possible ways in which a transmitter such as acetylcholine can act as a depressing or inhibiting agent: by the excessive depolarization that would be produced by prolonged action of a high concentration; by having different actions at different places on the nerve cell, a blocking action being produced by action at a certain site, for example, at the axon hillock; and by having opposite actions on different nerve cells, for example, depolarizing some and hyperpolarizing others, much as is assumed to occur with smooth muscle fibres. However, none of these three mechanisms explains the new findings of Prof. Eccles that the same nerve cell suffered a net depolarization or hyperpolarization according as it was being synaptically excited or inhibited. Since all dorsal root fibres appeared to be non-cholinergic, it could be assumed that acetylcholine was not concerned in the monosynaptic excitatory and inhibitory actions. Nor is there sufficient evidence that adrenaline and *nor*adrenaline are central synaptic transmitters.

Dr. Feldberg then went on to discuss the special problems raised by the observation that opposite actions are exerted in the same neurone by excitatory and inhibitory fibres. Investigations on peripheral cholinergic and adrenergic neurones make it improbable that different chemical transmitters would be released from different branches of the same nerve fibre; hence, if there were different central transmitters for excitation and inhibition, they would probably be located in different neurones, though acting on the same neurone. Dr. Feldberg concluded that one of the principal problems of chemical transmission in the central nervous system is the identification of the transmitting substances; only when that has been done will it be possible to determine how the opposite effects of excitation and inhibition are produced on a single neurone.

Finally, Prof. Eccles gave an account of experiments done in collaboration with Dr. L. G. Brock and J. S. Coombs in which the potentials were recorded by a micro-electrode that was inserted into motoneurones in the spinal cord of a cat. The entry of the micro-electrode into a motoneurone is immediately and unambiguously signalled by two events: the recording of the resting membrane potential (about 70 mV.); and the inversion and large increase in the antidromic spike potential, which gives a reversal of membrane potential of as much as 35 mV. Thus the properties of the motoneurone resemble those of the giant axon. A monosynaptic excitatory volley produces a depolarization of the motoneurone (the postsynaptic potential) which increases to a maximum within a millisecond and then decays with a time-constant of about four milliseconds. If the depolarization exceeds a critical value (about 10 mV.), a spike potential is generated that closely resembles the antidromic spike potential. On the other hand, a monosynaptic inhibitory volley (in the muscle spindle afferents from an antagonistic muscle) produces a hyperpolarization of the motoneurone that runs a similar time course, but is usually no larger than 2 mV. It is possible to account for the excitatory and inhibitory effects, respectively, by the depolar-

ization and hyperpolarization of the motoneurone. There is evidence, too, that both effects are due to brief action of a transmitter, the time-constant of decay being attributable to the electric time-constant of the neuronal membrane.

The Golgi-cell hypothesis of inhibition will not predict a net hyperpolarization and hence was rejected by Prof. Eccles in favour of a chemical transmitter mechanism, and chemical transmission also now seems probable for the synaptic excitatory action. But the experimental evidence has failed to reveal the nature of the transmitter action—for example, whether it causes a short-circuit of the membrane as at the motor end-plate. It was suggested that the inhibitory transmitter acts by stimulating the sodium pump. Finally, Prof. Eccles directed attention to the remarkable finding that the same type of afferent fibre produces depolarization of motoneurones of the homonymous or synergic motoneurones and hyperpolarization of antagonistic motoneurones. He made various suggestions in explanation of this effect by chemical transmitter actions, and thought it probable that the same transmitter substance depolarizes or hyperpolarizes the neuronal membrane by virtue of its action on specific patches of the surface membrane.

The general discussion at the symposium was continued for almost one and a half hours and ranged over many of the problems arising from these papers. It was opened by Sir Henry Dale, who recalled that Gaskell in 1886 had shown that the vagal inhibitory action on the tortoise auricle was associated with a hyperpolarization. The high standard of the questions and the lively character of the general discussion were among the most attractive features of the meeting, and indicated that a great deal of interest had been aroused and that the symposium had been very successful.

DISEASES OF THE HOP

WORK AT EAST MALLING RESEARCH STATION

AN intensive study of systemic hop diseases, which cannot be controlled by spraying, was started in 1938 at the East Malling Research Station and formed the subject of a 'members' day' at the Station on March 20, when about a hundred members were present.

Verticillium Wilt

Field surveys during 1938–39 showed that there were two types of outbreak. One, fluctuating wilt, was mainly characterized by generally mild symptoms, widespread and discontinuous distribution in the affected field, and the frequent recovery of affected plants; the other, progressive wilt, produced very severe symptoms, was usually lethal, and spread continuously outwards from localized foci. Further studies involving the isolation of the pathogen, and controlled inoculation through the soil showed the two types to be caused by distinct, though morphologically indistinguishable, races of the fungus *Verticillium albo-atrum*. The distribution and history of the progressive outbreaks suggest that the more virulent race originated as a mutant of the mild race.

The progressive fungus was found to enter the roots from the soil, whence it invaded the plant, growing up into the stems and eventually into the leaves, which died and fell off. The latter were carried on implements with infected stem debris, and were blown from farm to farm, thus spreading the disease. By 1944 some eighty farms were affected in the important Weald hop area, and many acres of good hop land were rendered derelict. Attempts were first made to check the advance of this disease by the systematic removal of infected plant debris, and a Ministry of Agriculture Order was promulgated to enforce such precautions. Other measures tried were the disinfection of the soil and the fallowing of affected fields. As none of these measures was completely effective, a search was made for hop varieties resistant to the disease. All the commercial varieties proved susceptible; but certain of the 'Wye seedlings' (bred by Prof. E. S. Salmon and mainly of American parentage) proved highly resistant although not immune. New propagation methods were evolved to multiply the small stocks of these rapidly, and two were eventually selected, on the results of brewing tests, for extension trial. Large-scale propagation was then undertaken by the Hops Marketing Board, and these two varieties were widely distributed. They have withstood the disease well under commercial conditions and seem of considerable promise; but as they may not prove entirely satisfactory for brewing, new breeding and testing work is now in progress to raise more generally acceptable varieties.

More fundamental studies on the host–pathogen relations included experiments on nutritional factors, both in sand culture and in the field. These have shown that hop plants starved of nitrogen become highly resistant to the disease, a conclusion also reached by workers on wilt diseases of other crops. But such high resistance has not yet been induced by any other manurial adjustments and at present has no commercial application.

A study in detail of the process of invasion by *Verticillium* aims at elucidating the nature of varietal resistance. Toxins have been derived from the two races of the pathogen growing in artificial culture, and their effects on the water-balance relationships of hop stems are now being studied by a new technique. Stems of resistant and susceptible varieties are being compared in this way. Composite plants made of reciprocal graft combinations of resistant and susceptible varieties, and inoculated via root-stock and stem, are also being used in this study. Results to date indicate that the root-system may be regarded as the prime determinative seat of the disease.

Further research on this disease will be concentrated more particularly on breeding and testing for varietal resistance, in collaboration with the Hop Research Department of Wye College, and on a continuation of the studies of host–pathogen relationships.

Virus Diseases

Although some early attention was given to virus diseases, it was not until 1948 that an intensive investigation into their diagnosis, etiological relationships, natural vectors, and control was started. At that time two major diseases were recognized—mosaic, already shown to be transmissible by grafting by Salmon and Ware, and nettlehead—the former causing rapid necrosis of the stems soon after the appearance of incipient symptoms, and the latter reducing infected plants to unproductiveness. Other diseases such as the mechanically transmissible

chlorotic disease were recognized, and certain types of symptom such as split leaf blotch and fluffy tip were suspected as being probably caused by viruses. Later, the virus origin of both nettlehead and split leaf blotch were confirmed by graft-transmission, but, with the exception of chlorotic disease, no natural method of plant-to-plant transmission has yet been conclusively determined for any hop virus disease. That mosaic and nettlehead do spread by means other than indiscriminate vegetative propagation has been shown by year-to-year surveys, and during the past four years the work has been mainly concentrated in determining whether insects are the natural agents of such spread.

As a preliminary to such a study, records were made of all insects visiting the hop and, in particular, hops where virus diseases were known to be spreading. Initial attempts to transmit mosaic disease by insects included such methods as: (1) mass periodic transfers of insects from plantations where the disease was known to be spreading, to indicator varieties in an insect-proof glasshouse; (2) periodic transfer of indicator plants in pots to such a plantation and subsequent restoration to the insect-proof glasshouse; and (3) the mass infection with suspected vector species of infector plants in pots provided also with indicator plants and kept in an insect-proof glasshouse. Positive results by such mass infections have been analysed in further experiments using individual insects, and to date a line-pattern type of symptom has been transmitted to an indicator hop variety by the common hop damson aphid, *Phorodon humuli* Schr. Probably owing to a long incubation period in the indicators used and very irregular and easily masked expression, vector determinations for nettlehead have not yet yielded results. But certain peculiarities in the incidence and spread of this disease recorded in the early years of this investigation are being studied, namely, the association of outbreaks with cleared hedgerows and old pasture sites. Split leaf blotch as a frequent precursor of nettlehead is also being studied from the point of view of a possible virological relationship of the two diseases.

In addition to such studies in diagnosis, modes of natural transmission, and virus analysis, a study of varietal reaction has shown that certain varieties are symptomless carriers of mosaic, including the widely grown fuggle hop and certain male hops. Work is being directed to indexing the new seedling varieties in this respect.

Propagation of Healthy Planting Stock

One important step in the control of both *Verticillium* wilt and virus diseases of the hop is the production of healthy planting stock. New intensive propagation methods now make it possible for such stock to be produced in areas far away from commercial hops. In such areas the chances of retaining the initial health of selected material are greater than in the hop districts, and the establishment of special nurseries is thus being encouraged. Such nurseries are especially necessary in the case of varieties resistant to wilt, since plants of these varieties grown on an infected farm may carry wilt disease to other farms, although they appear outwardly healthy. Provision is also needed for maintaining a small basic supply of healthy stocks of the commercial varieties and new seedlings from which such nurseries can periodically be renewed.

W. G. Keyworth
R. V. Harris

THE METABOLISM OF ETHYL ALCOHOL*

By Dr. ERIK JACOBSEN
A/S Medicinalco, Copenhagen, S.

THE principal factors relating to the distribution and the elimination of alcohol in the organism have been known since the publication of the investigations commenced in 1919 by Mellanby and followed up by Widmark in his comprehensive publications during 1922–35. It is possible to follow the rate of disappearance of alcohol in the organism by determination of the concentration of alcohol in the blood. Both Mellanby and Widmark found the curve for the elimination of alcohol from the organism to be rectilinear, and in man an average of 15 mgm. per cent alcohol disappears from the blood per hour, the range being 10–20 mgm. per cent (Widmark's β-factor). For the same individual this rate of elimination was found to be constant and independent of many factors, especially of the alcohol concentration in the blood (and tissues), of the habituation to alcohol of the individual, and of the general metabolism.

The total amount of alcohol present in the organism can be calculated from the blood-alcohol concentration by multiplying this by the body-weight and a factor (Widmark's r-factor). In man, r is fairly constant within the same individual, but can vary somewhat from individual to individual, between 0·50 and 0·90 with an average of 0·66. These facts are generally known and form the basis for practical calculations, especially in medico-forensic practice, where it is of importance to estimate the amount of alcohol consumed from the blood-alcohol concentration or vice versa.

Nevertheless, a long series of reliable experiments have shown that the above principles are not valid in all circumstances[1]. Some investigators have found an increase of alcohol metabolism up to 100 per cent or even more after administration of dinitrophenol, insulin and glucose, pyruvate or alanine; but the accelerating effect seems only to take place if the initial elimination-rate of alcohol is low, and investigators who have worked with animals having a high initial elimination-rate have failed to observe any effect with these substances. During recent years, evidence has also been collected showing that the metabolic rate of alcohol is not completely independent of the alcohol concentration in the tissues. Not only is the elimination curve of alcohol in cats, rabbits and sometimes in dogs found to be more-or-less hyperbolic with a higher rate at greater concentrations of alcohol, but also, in dogs, Newman and his asssociates have observed a peculiar phenomenon, termed by them 'conditioning'[2]. If a moderate dose of alcohol is administered to a dog, resulting in a concentration of about 100 mgm. per cent in the blood, a rectilinear elimination curve with a certain slope will be found. If a higher dose is given, resulting, for example, in a maximum blood-alcohol concentration of 300 mgm. per cent, a rectilinear elimination curve is also found, but the slope is now much steeper than that seen after administration of the smaller dose. When, however, a small dose is given shortly after the elimination of a high dose, the elimination of this smaller dose proceeds at a rate

* Based on a Special University Lecture delivered at University College, London, on January 28.

not corresponding to the first small dose given, but at the same rate as obtained after the high dose just eliminated. Apparently the high dose has 'conditioned' the organism to a high capacity of elimination of alcohol. Even in man some recent investigations have shown that high doses really are eliminated at a somewhat faster rate than smaller doses[3,4]; but the differences are so slight that many experiments are necessary in order to get statistically significant figures, and it is not possible to decide whether this phenomenon is represented by a slightly hyperbolic curve or is due to a conditioning. Finally, a third observation suggests a dependence of the rate at which alcohol is metabolized on its concentration. As mentioned later, the first step in the oxidation of alcohol in the organism is acetaldehyde. If the alcohol were oxidized at the same rate independently of the concentration in the organism, it would be expected that the amount of acetaldehyde formed per unit of time would be independent of the alcohol concentration. However, this is not the case. There is a definite increase of acetaldehyde concentration in the blood with increasing alcohol concentrations, both in normal organisms and in organisms in which the acetaldehyde metabolism has been inhibited[5,6]. This can only mean that alcohol is metabolized at a somewhat higher rate at higher compared with lower concentrations. However, these observations are of no practical importance for medico-forensic calculations in which the rule of a constant elimination-rate still can be applied; but nevertheless they are of great theoretical interest.

A maximum of 5 per cent of the ethyl alcohol in the organism is eliminated unchanged in the urine and sweat, both having the same concentration of alcohol as the water phase of the blood and of the expired breath, of which 2 litres contains the same amount of alcohol as found in 1 ml. of blood. The rest is completely oxidized to carbon dioxide and water. This was already known at the turn of the century; but in 1949 it was confirmed by radioactive tracers. Ninety per cent of the radioactive carbon-14 in ethyl alcohol administered to rats[7] was excreted as radioactive carbon dioxide over a period of ten hours in the expired breath.

The oxidation proceeds in steps: alcohol is first oxidized to acetaldehyde, which in turn is oxidized to acetic acid. The capacity of the organism to oxidize acetaldehyde to acetic acid is much greater than the capacity to oxidize alcohol to acetaldehyde. Therefore, in normal circumstances, the concentration of acetaldehyde in the organism during alcohol metabolism will be low. It is, however, possible to inhibit the oxidation of acetaldehyde by certain drugs. In this case the acetaldehyde concentration in the organism will be considerably increased during alcohol metabolism. This fact has recently gained some practical importance. Administration of appropriate doses of tetraethylthiuramdisulphide ('Antabuse') results in a higher concentration of acetaldehyde than is normally found in the organism during the metabolism of alcohol[8], and, as increased concentration of acetaldehyde causes some very marked and unpleasant symptoms[9,10], persons under the influence of 'Antabuse' will feel a changed and undesirable effect of alcohol. Experience has shown that people who have felt this effect will abstain from alcohol as long as they are under the influence of 'Antabuse', a fact which is utilized in the therapy of alcoholics[11]. 'Antabuse' inhibits the flavin-containing aldehyde oxidases[12,13], and the aldehyde dehydrogenase[14], of the organism. *In vitro* concentrations about $1/10^7$ give a marked inhibition of the enzymatic actions, and the degree of inhibition is diminished with increasing concentrations of the substrates, suggesting a competition between 'Antabuse' and aldehyde for the enzyme. With aldehyde dehydrogenase, which requires diphosphopyridine nucleotide as a coenzyme, the inhibition can be partly abolished by increased concentrations of the coenzyme, suggesting that 'Antabuse' also competes with the coenzyme for the active centres of the enzyme[14]. The competition between 'Antabuse' and substrate seen in the *in vitro* experiments conforms well with the experiments *in vivo* showing a higher inhibiting effect of 'Antabuse' with low concentrations of acetaldehyde than with high concentrations[15]; thus, 'Antabuse' does not completely block the oxidation of acetaldehyde in the organism, but a higher concentration of acetaldehyde is necessary in the tissues in order to oxidize the amount of acetaldehyde formed by the oxidation of alcohol. This explains readily the increased level of acetaldehyde during alcohol metabolism in persons under the influence of 'Antabuse' or compounds with a similar effect. Acetaldehyde is in its turn oxidized to acetic acid. Apart from some *in vitro* experiments, convincing evidence for this process was given by Bernhard, who showed that substantial amounts of deuterium were found in the acetyl group of acetylated sulphonamide in the urine from animals given C_2D_5OD together with a sulphonamide which is excreted in the acetylated state[16]. Acetic acid is a normal intermediate in the oxidation of fats and carbohydrates, and this fact explains why alcohol can replace the calorie-producing factors of normal nutrition.

The two first steps in the oxidation of alcohol take place mainly in the liver. Eviscerated animals have practically no capacity for oxidizing alcohol, and in partly hepatectomized animals the rate of metabolizing alcohol depends on the amount of liver tissue left in the organism[17]. Isolated surviving livers perfused artificially with aerated blood have a capacity for oxidizing alcohol of about five-sixths that of the whole organism[18–19]; but the alcohol is not completely oxidized in the liver, as a substantial amount of acetic acid is formed, the energy of which can be utilized by other tissues, preferably the muscles[19].

Two different enzyme systems are necessary for the oxidation of alcohol to acetic acid: one catalysing the oxidation of alcohol to acetaldehyde, and the other catalysing the oxidation of acetaldehyde to acetic acid. According to our present knowledge, only two enzymes play a part in the oxidation of alcohol to acetaldehyde: alcohol dehydrogenase and catalase. Both have been isolated in a crystalline state and their properties have been studied.

Alcohol dehydrogenase[20,21] catalyses the process:

$$\begin{array}{l} CH_3 \\ | \\ CH_2OH \end{array} + DPN \xrightleftharpoons{\text{alcohol dehydrogenase}} \begin{array}{l} CH_3 \\ | \\ CHO \end{array} + DPNH + H^+$$

DPN represents diphosphopyridine nucleotide (cozymase).

Both in the oxidized and the reduced state the coenzyme is bound to the enzyme and reacts only with alcohol or acetaldehyde when bound to the enzyme[21]. As indicated in the equation, the process

is reversible—at the *p*H of the organism, sixty molecules of alcohol are in equilibrium with one molecule of acetaldehyde. The process proceeds from left to right in the organism because acetaldehyde is readily further oxidized and thus removed from the system.

In the presence of catalase, hydrogen peroxide is able to oxidize alcohol to acetaldehyde[22]. Generally the substrates forming hydrogen peroxide are not found in any substantial amount in the organism, but the acetaldehyde formed by the oxidation of alcohol can be further oxidized in the organism by the flavin-containing enzymes, xanthine (or aldehyde) oxidases, with the formation of hydrogen peroxide. In this way a circular process will proceed:

$$CH_3.CH_2.OH + H_2O_2 \xrightarrow{\text{catalase}} CH_3.CHO + 2H_2O$$

$$CH_3.CHO + H_2O + O_2 \rightarrow CH_3.COOH + H_2O_2$$

Actually, this process takes place *in vitro* with pure enzymes[23].

The kinetic data found in experiments with the pure enzymes can give considerable information as to the possible importance *in vivo* of the two processes already mentioned. There is sufficient alcohol dehydrogenase present in the liver to explain the rate of oxidation of alcohol in the intact organism. Bonnichsen's yield of crystalline alcohol dehydrogenase was 1 gm. per kgm. horse liver[20], and, provided that the same concentration is found in human liver, at least 1·5 gm. on an average should be present there. When the enzyme is fully saturated with the coenzyme, the turnover number of the enzyme is 150, which means that, the molecular weight of the enzyme being taken as 73,000, then 1·5 gm. enzyme can oxidize 8–9 gm. alcohol per hour, which is about the rate of oxidation actually found in man[20]. In addition, the kinetic data show that the rate of alcohol oxidation catalysed by alcohol dehydrogenase is independent of the alcohol concentration down to concentrations so low that they cannot be determined by the usual clinical methods[20].

In this way the function of the alcohol dehydrogenase explains both the oxidation-rate and the rectilinear course of ethanol oxidation in the organism; but the fact that methanol can be oxidized in the organism shows that other enzymatic pathways must also be considered. There seems to be an intimate connexion between the oxidation of methanol and ethanol in the organism, as high concentrations of the latter are able to inhibit the rate of metabolizing methanol[24,25,26]. This can be utilized in cases of methanol poisoning, where high and continued doses of ethanol given to the patients cause a delay in the oxidation-rate of methanol so that formic acid, in concentrations dangerous to sight or life, are not formed[27]. Alcohol dehydrogenase is unable to catalyse the oxidation of methanol[21], but catalase can[28]. Moreover, the slope and the shape of the elimination curve of methanol *in vivo*, definitely depending on the concentration of methanol, conform with the kinetic data of the binding of catalase with methanol, which supports the assumption that the oxidation of methanol is catalysed by the catalase systems[24]. *In vitro* the oxidation of methanol and ethanol by catalase–hydrogen peroxide proceeds at approximately the same rate, and if the same is the case *in vivo* we have an indication of the relative part played by the catalase system in alcohol metabolism. As the oxidation-rate of methanol in the human organism is about a quarter that of ethanol, about 80 per cent of the ethanol can be expected to be oxidized by the alcohol dehydrogenase system and the rest by the catalase–acetaldehyde oxidase system. The possibility that four-fifths of the alcohol elimination in man is due to alcohol dehydrogenase, the action of which is independent of the concentration of alcohol, explains why the alcohol elimination curve does not deviate from the straight line within the error of the alcohol determination; and if a fifth of the oxidation is due to the catalase system, the effect of which is dependent on the concentration of the substrate, it explains why we find indications of a dependence on alcohol concentration in certain circumstances.

However, the phenomenon of conditioning cannot be explained in this way, and there are other possibilities which may offer an explanation. The capacity of the alcohol dehydrogenase to oxidize alcohol depends on the amount of coenzyme available in the system, and the calculation discussed in the previous paragraph is based on the assumption that the enzyme is fully saturated with the coenzyme. As cozymase also is bound to other enzymes, it is not certain that the alcohol dehydrogenase is in all circumstances fully saturated[21], and an increase in the coenzyme available will increase the capacity of the enzyme. If the oxidation of high concentrations of alcohol in some way or another is able to release coenzyme from other enzymes and make it available for the alcohol dehydrogenase, a higher oxidation-rate will be the result. Nothing in the literature is contrary to this suggestion; but it must be emphasized that it has to be tested experimentally before it can be regarded as more than a working hypothesis.

[1] Jacobsen, E., *Pharmacological Rev.* (in the press).
[2] Newman, N. W., *Quart. J. Stud. Alc.*, **8**, 377 (1947).
[3] Hjelt, E., *Tirfing*, **43**. 150 (1949).
[4] Goldberg, L., "Verkan på den mänsklige organismen av maltdrycker med olika alkoholhalt" (Stockholm, 1951).
[5] Hald, J., Jacobsen, E., and Larsen, V., *Acta Pharmacol. et Toxicol.*, **5**, 179 (1949).
[6] Raby, K. (unpublished data).
[7] Barlett, G. R., and Barnet, H. N., *Quart. J. Stud. Alc.*, **10**, 381 (1949).
[8] Hald, J., and Jacobsen, E., *Acta Pharmacol. et Toxicol.*, **4**, 305 (1948).
[9] Hald, J., Jacobsen, E., and Larsen, V., *Acta Pharmacol. et Toxicol.*, **4**, 285 (1948).
[10] Asmussen, E., Hald, J., and Larsen, V., *Acta Pharmacol. et Toxicol.*, **4**, 311 (1948).
[11] Martensen-Larsen, O., *Lancet*, ii, 1004 (1948).
[12] Kjeldgaard, N. O., *Acta Pharmacol. et Toxicol.*, **5**, 397 (1949).
[13] Richert, D. A., Vanderlinde, R., and Westerfeld, W. W., *J. Biol. Chem.*, **186**, 261 (1950).
[14] Graham, W. D., *J. Pharmacy and Pharmacol.*, **3**, 160 (1951).
[15] Hald, J., and Larsen, V., *Acta Pharmacol. et Toxicol.*, **5**, 292 (1949).
[16] Bernhard, K., *Z. physiol. Chem.*, **267**, 99 (1940).
[17] Mirsky, J. A., and Nelson, N., *Amer. J. Physiol.*, **126**, 587 (1939).
[18] Flessinger, N., Benard, H., Courtial, J., and Dernier, L., *C.R. Soc. Biol.*, **132**, 1255 (1936).
[19] Lundsgaard, E., *C.R. Trav. Lab. Carlsberg*, Ser. chim., **22**, 333 (1938).
[20] Bonnichsen, R. K., and Wassen, A. M., *Arch Biochem.*, **18**, 361 (1948).
[21] Theorell, H., and Bonnichsen, R. A., *Acta Chim. Scand.*, **5**, 1105 (1951).
[22] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **119**. 141 (1936).
[23] Keilin, D., and Hartree, E. F., *Biochem. J.*, **39**, 293 (1945).
[24] Bartlett, G. R., *Amer. J. Physiol.*, 619 (1950)
[25] Zatman, L. J., *Biochem. J.*, **40**, lxvii (1946).
[26] Agner, K., and Belfrage, K. E., *Acta Physiol. Scand.*, **13**, 87 (1947).
[27] Røe, O., *Acta Med. Scand.*, **113**, 558 (1943).
[28] Chance, B., *Acta Chim. Scand.*, **1**, 236 (1947).

OBITUARIES

Dr. G. W. M. Findlay

The sudden death of George William Marshall Findlay on March 14 at the early age of fifty-nine has deprived the world of an outstanding virologist. He appeared to be in full vigour to the last, when he was deeply immersed in researches on poliomyelitis and other virus diseases. He was born in Warwickshire, and was educated at Dean Close School and the University of Edinburgh. He served with great distinction in both World Wars, in the first as a surgeon lieutenant, in the second as brigadier and consulting physician. He began his career as lecturer in pathology in the University of Edinburgh, then joined the staff of the Imperial Cancer Research Fund, and in 1929 went to the Wellcome Research Institute, where his reputation became finally established. After the Second World War, he took the surprising step of becoming editor of *Abstracts of World Medicine* and of *World Surgery, Obstetrics and Gynæcology*, a full-time appointment for an ordinary man, but for Findlay, merely a useful adjunct to his laboratory work, which he continued in accommodation provided by the Pharmaceutical Society.

Findlay's talents were of two kinds: an avid mind absorbed at remarkable speed all the literature, however remote, relating to his subjects, and converted it into clear expositions like his "Recent Advances in Chemotherapy", now half-way through its third edition, or general articles like "The Virus and the Cell", published recently in the *Journal of the Royal Microscopical Society*. He had been president of this Society, and had edited its journal for many years. His second talent was his research ability, and an endless curiosity left him never satisfied—in almost his last paper, he recalls the scientific paradox that the fuller our knowledge of a subject the larger becomes the unknown field of our ignorance. His most notable work was on yellow fever: preparation of vaccine, the distribution of immunity in man and animals in Africa, and studies on the virus. He carried out fundamental research on rift valley fever, fowl pest, lymphocytic choriomeningitis, and lately on the Coxsackie virus. During the Second World War, he made interesting observations on blackwater fever and malaria, the sickling phenomenon, and on tropical typhus on West African natives.

Findlay's work led him far afield, to the United States, Africa and to Europe. He much valued his associations with the Pasteur Institute and France, and the tragic death in 1949 of his collaborator, Stephanopoulo, was a heavy blow. Findlay is survived by a widow and two daughters.

P. C. C. Garnham

We regret to announce the following deaths:

Dr. E. H. Farmer, F.R.S., formerly assistant director of research, British Rubber Producers' Research Association, on April 13, aged sixty-two.

Mr. J. E. Hodgson, honorary Fellow of the Royal Aeronautical Society, author of "History of Aeronautics in Great Britain from the Earliest Times to the Latter Half of the Nineteenth Century" (1924), on April 10.

NEWS and VIEWS

Corpus Christi College, Cambridge: Sir Will Spens, C.B.E.

Sir Will Spens, Master of Corpus Christi College, Cambridge, is to retire in August. Sir Will's connexion with the University of Cambridge has been long and close. He was in residence as an undergraduate at King's College in 1901, was elected Fellow of Corpus Christi College in 1907, Tutor in 1912, and Master in 1927. He has been prominent in University as well as in College affairs, for in 1923 he was a member of the Statutory Commission for the University of Cambridge which drafted the statutes by which the University is still largely governed, and was Vice-Chancellor during 1931–33. He served on the Royal Commission for the University of Durham in 1934, was chairman of the Universities Bureau of the British Empire during 1934–38, and was regional commissioner for Civil Defence in the Eastern Region during the War. He was chairman of the Consultative Committee on Secondary Education with Special Reference to Grammar Schools and Technical High Schools which issued its famous report in 1939. From 1946 until 1948 he presided over the interdepartmental committees on the remuneration of general medical practitioners, consultants and specialists, and dental practitioners. He is also chairman of the governing body of Rugby School. With this record of public service, Sir Will Spens has exerted a notable influence in academic circles. He has been a distinguished head of a House for twenty-five years and has helped to guide the University in a period of change and stress. On the larger world of education he has also left his mark, most recently as chairman of the committee on the remuneration of consultants and specialists, the recommendations of which were designed equitably to adjust the conditions of service of medical specialists on transition from independent to national service and which indirectly affected the entire teaching staffs of the universities of Great Britain.

Sir George Thomson, F.R.S.

Sir George Thomson, who is to succeed Sir Will Spens as Master of Corpus Christi College, Cambridge, became head of the Department of Physics, Imperial College of Science and Technology, London, in 1930. He came from the chair of natural philosophy in Aberdeen, with a remarkable record of achievement in such diverse fields of experimental physics as aerodynamics, the conduction of electricity in gases and electron dynamics. Thomson's experimental proof of the wave-like behaviour of moving electrons will, with its profound and revolutionary effect on scientific outlook, rank as one of the great key experiments in physics. By recording photographically the directions into which an electron beam is scattered on passing through thin films of matter, Thomson not only established the validity of de Broglie's ideas for reconciling the wave and particle aspects of radiation, but, with characteristic insight, was also quick to realize that he had provided means for the direct study of the atomic structure of thin films and surfaces. To-day, the electron-diffraction camera is as indispensable in the well-equipped

physics or chemistry laboratory as the balance or the microscope.

At the Imperial College, while continuing to make, by ingenious use of electron diffraction, notable contributions to our knowledge of the physics and chemistry of surfaces, Thomson turned his attention more and more to the field of atomic physics and, in particular, to the neutron. That the atomic energy project was embarked on with maximum effort early in the War was due to Thomson's grasp of the subject and his almost prophetic vision. In returning to Cambridge, the brilliant son, a Nobel laureate and Royal and Hughes medallist of the Royal Society, is following still further in the footsteps of his father, the great "J. J.", and the Imperial College loses a famous man of science and a stimulating lecturer and conversationalist for whom his friends and colleagues have real affection and admiration.

Meldola Medal, 1951

THE Meldola Medal is the gift of the Society of Maccabæans and is normally awarded annually, the award for any year being made to the chemist who, being a British subject and less than thirty years of age at December 31 in that year, shows the most promise as indicated by his or her published chemical work. On the recommendation of the Council of the Royal Institute of Chemistry, the Society has decided to award two medals for 1951, there being two candidates adjudged to be of equal merit in diverse fields of work; they are Dr. C. Kemball and Dr. G. W. Kenner.

Dr. C. Kemball

Dr. Kemball was educated at Edinburgh Academy and Trinity College, Cambridge. In 1943 he joined the Department of Colloid Science, University of Cambridge, working with Prof. E. K. (now Sir Eric) Rideal on the adsorption of vapours on mercury. The researches showed that many of the phenomena that were known to occur with surface films of long-chain molecules on water also took place with smaller molecules on the more strongly adsorbing mercury surface, and led to interesting developments in the use of entropy measurements for investigating the state of adsorbed substances. In 1946 he was elected to a fellowship at Trinity College and to a Commonwealth Fund fellowship at Princeton University, where, in collaboration with Dean H. S. Taylor, he studied the catalytic rupture of the carbon-carbon bond in ethane on nickel surfaces. Returning to Cambridge in 1947, Dr. Kemball applied the technique of surface potentials to following chemisorption of vapours on mercury and, in the Department of Colloid Science and later in the Department of Physical Chemistry, developed a mass spectrometer for studying catalytic reactions on evaporated metal films.

Dr. G. W. Kenner

Dr. Kenner entered the Victoria University of Manchester in 1939, obtaining a B.Sc. in 1942, and the M.Sc. degree in 1943. His first work was on the reactions of amidines with derivatives of malonic acid and the synthesis of pyrimidine derivatives. These substances were used in his work in Manchester, and then after 1944 in Cambridge, on the synthesis of purine nucleosides, work which culminated in 1948 with the synthesis of adenosine. In 1944 Kenner went to Cambridge as a research student and was awarded the Darwin Prize for his Ph.D. dissertation in 1946. At this time he was elected a Fellow of Trinity Hall, Cambridge. During the academic year 1948–49 his tenure of a Rockefeller fellowship enabled him to spend a year at the Eidgenössische Technische Hochschule, Zurich, studying the structure of the erythrina alkaloids with Prof. V. Prelog. Since his return to Cambridge in 1949, Dr. Kenner has been collaborating with Prof. A. R. Todd in his work on the synthesis of oligonucleotides, while developing another investigation into the peptide field. This has led to new methods for the synthesis and selective degradation of peptides, such as form the active constituents of the pituitary hormones.

Safe Transit of Delicate Instruments across National Frontiers

FROM time to time, research laboratories making very precise scientific measurements need to exchange instruments, for purposes of comparison, with similar laboratories in other countries, and if these, often very delicate, instruments are to reach their destination undamaged, they must be handled with extreme care during the customs inspection in both exporting and importing countries. As part of its objective of reducing administrative and other barriers to the passage of educational and scientific materials from country to country, Unesco (19 Avenue Kléber, Paris 16e) is sponsoring a scheme whereby the inspection of these instruments is made in the laboratories themselves, under competent supervision, rather than in customs depots at national frontiers or terminals. Each Government participating in the scheme would name the laboratory or laboratories in its country to which it wished to extend the privileges of the scheme. The actual procedure might vary from country to country. Under an arrangement suggested by the United Kingdom, a customs officer would supervise the packing of an instrument at an exporting laboratory and affix an internationally recognized label. The authorities at the place of importation would allow the package to be forwarded unopened to its destination, where it would be opened in the presence of a customs official. Unesco will keep a register of laboratories designated by Governments and would periodically send to interested countries a list of these laboratories, as well as details of operation. Information reaching Unesco by June 1 will be included in the first circular.

The scheme seeks to apply more widely an arrangement already operating among a limited number of laboratories as follows: the National Physical Laboratory, Teddington; Conservatoire des Arts et Métiers, Paris; Physikalisch-Technische Bundesanstalt, Brunswick; Deutsches Amt für Maasse und Gewichte, Weida; Electrotechnical Laboratory and the Central Inspection Institute of Weights and Measures, Tokyo; National Bureau of Standards, Washington, D.C.; and the Institute of Metrology of the U.S.S.R., Leningrad. These institutions at present conduct exchanges on a limited scale and also maintain regular contact with the International Bureau of Weights and Measures for the purpose of exchanging apparatus and scientific data. The Bureau itself maintains an international laboratory at its headquarters at Sèvres, near Paris, which exchanges physical standards and scientific data with leading national laboratories. Both the Bureau and the International Council of Scientific Unions have endorsed the proposal as a practical means of reducing obstacles to the international exchange of scientific information.

Society for Water Treatment and Examination

At a meeting at the Royal Institute of Chemistry on March 15, attended by some thirty chemists or microbiologists engaged in water treatment and examination, whether for public supply or industrial purposes, it was unanimously decided to form a Society for Water Treatment and Examination. The following officers were elected: *Chairman*, G. U. Houghton; *Hon. Secretary*, A. W. H. McCanlis (c/o Sutton District Water Company, 41 Carshalton Road, Sutton, Surrey); *Hon. Treasurer*, A. G. Knight; *Committee*, H. G. Cheeseworth, J. D. Joseph, W. S. Holden and L. Allen.

It was decided that there should be no entrance fee and that the annual subscription be £1 1*s*. 0*d*. It was also decided that the Society should meet at least twice per annum, once in London for the annual general meeting and the second time, if possible, outside London. The Society is open to all *bona fide* chemists or microbiologists who are engaged in the treatment or examination of waters. The aims of the Society are to assist its members by the reading of technical papers and the informal discussion of subjects relating to the treatment or examination of waters at the meetings of the Society. It is also proposed to organize and arrange visits by members to works and laboratories engaged in water treatment or examination, so that members should have an opportunity of seeing for themselves methods or techniques which may be new to them. It is also hoped that the Society will be invited to confer with government departments, committees and other interested bodies on matters relating to water treatment and examination, including training, qualifications, and duties of personnel.

Council for the Promotion of Field Studies

Following a series of articles on the field study and research centres maintained by the Council for the Promotion of Field Studies, an article commending the Council's work and inviting support for it was published in *Nature* of June 30, 1951. It is now announced that Imperial Chemical Industries, Ltd., has decided to enter into a deed of covenant in favour of the Council, for £750 per annum, for the seven years 1952–58. The annual Treasury maintenance grant which the Council receives through the Ministry of Education has recently been much reduced, and it is hoped that the present donation from Imperial Chemical Industries, Ltd., may set an example which other industrial bodies will wish to follow. The Council is also endeavouring to build up a bursary fund to assist deserving students who would otherwise be unable to work at the field-centres. Unfortunately, these are now very numerous owing to a widespread curtailment of grants for field-work by local education authorities.

Radar Echoes from Lightning Discharges

Considerable interest has been recently aroused by the observation of radar echoes from lightning discharges; such observations would seem to offer a new method of investigating conditions in the discharge channel. The earliest observations of this type were described, in 1944, by J. L. Pawsey (Radiophys. Lab. Rep., RP.49.2; C.S.I.R.O., Australia, 1944), who was working on a wave-length of 150 cm. Hisao Shôno, Institute of Science and Technology, University of Tokyo, writes to direct attention to Japanese observations on a wave-length of 400 cm. (*Kagaku*, **17**, 367 (1947); **18**, 458 (1948). *Rep. Inst. Sci. Tech.*, **1**, 184 (1947); **2**, 20 (1948)). More recently, lightning echoes have been observed on considerably shorter wave-lengths (10 cm.) by M. G. H. Ligda in the United States (*Bull. Amer. Met. Soc.*, **31**, 279 (1950)), and by I. C. Browne (wave-length 3·2 cm.) working in England (*Nature*, **167**, 438 (1951)). Some of the features which emerge from these observations are summarized in the following table; the variation of apparent duration of the echo with wave-length is interesting and suggestive.

Date	Observer	Wave-length	Estimated duration of echo	Remarks
1944	Pawsey	150 cm.	—	Intensity estimate
1947–48	Shôno	400	200 (m.sec.)	—
1950	Ligda	10	20	—
1951	Browne	3·2	2	Intensity estimate

Museums Association: Revised Grades of Membership

The Museums Association has adopted new Articles of Association which came into effect as from April 1 and establish seven classes of membership, as follows: honorary fellows, fellows, associates, ordinary professional members, non-professional members, student members and institutional members. Existing members of the Association have been classified into the new grades in accordance with their known qualifications, achievements and experience. In future, however, admittance to the grade of associateship will be dependent on passing the Association's diploma examinations, while elections to fellowship will be restricted to associates, of not less than five years standing, who have made outstanding contributions to the direction or literature of museums and art galleries; these professional qualifications will be indicated by the letters A.M.A. and F.M.A. respectively. Institutional membership is an arrangement whereby museums and similar bodies may join the Association corporately. The remaining classes of membership exist for those who do not wish to take or do not pass the qualifying examinations or who, though interested, are not professionally engaged in museum or art gallery work, and for students working for the diploma examinations. The Association on April 1 consisted of 383 institutional members and 558 individual members of various grades; the new lists of these are being published in the April issue of the *Museums Journal* (obtainable from the Museums Association, Meteorological Buildings, Exhibition Road, London, S.W.7).

Reindeer Council of the United Kingdom

The Reindeer Council of the United Kingdom, Annesley House, 1*a* Union Road, Cambridge, announces that it has received the approval of the Scottish Department of Agriculture for the use of 300 acres offered by Lieut.-Colonel J. P. Grant, of Rothiemurchus, for the first phase of an experiment with reindeer in Scotland. Work on the fence around the Rothiemurchus Forest Reindeer Reserve began in January. Mr. Mikel Utsi, a Swedish reindeer owner who is technical adviser to the Council, is sending a first consignment of eight reindeer from Narvik. The Royal Zoological Society of Scotland has offered quarantine accommodation in its park at Edinburgh, where the reindeer will remain 28 days. The Reindeer Co., Ltd., registered in Edinburgh on February 12, will carry out the practical detail of the experiment.

Ray Society: Annual General Meeting

THE one hundred and seventh annual general meeting of the Ray Society was held on March 27. Two books, "British Spiders, Vol. 1", by G. H. Locket and A. F. Millidge, and "British Mysidacea", by the late Prof. W. M. Tattersall and Mrs. O. S. Tattersall, were published and distributed during the past year. It was announced that "British Spiders, Vol. 2", by G. H. Locket and A. F. Millidge, was being sent to press, that "Watsonian Vice-counties", by J. E. Dandy and E. W. B. H. Milne-Redhead, would soon be ready for press, and that "British Sponges, Vol. 1", by Dr. Maurice Burton, would be ready for press later in the year. Officers of the Society were elected as follows: *President*, Lieut.-Col. R. B. Seymour Sewell; *Vice-Presidents*, Dr. John Hutchinson and Dr. Errol White; *Honorary Treasurer*, Lieut.-Col. W. P. C. Tenison; *Foreign Secretary*, Arthur Exell; *Honorary Secretary*, Dr. Maurice Burton; *New Members of Council*, Dr. B. F. Barnes, Dr. Edward Hindle, Mr. G. H. Locket and Dr. H. W. Parker. An additional rule, passed at this meeting, permits the election, as honorary vice-presidents, of those who have rendered conspicuous services to the Society. The first to be elected are: Dr. G. P. Bidder, Dr. W. T. Calman, Prof. F. E. Weiss and Mr. J. Spedan Lewis.

University of London

THE following appointments have been made in the University of London: Mr. W. R. Dean, lecturer in mathematics in the University of Cambridge, to the Goldsmid chair of mathematics tenable at University College, from October 1; Dr. H. C. Longuet-Higgins, reader in theoretical chemistry in the University of Manchester, to the University chair of theoretical physics tenable at King's College, from October 1. The title of reader has been conferred on the following in respect of the posts held by them in the Royal Veterinary College: Mr. H. R. Allen and Mr. J. W. H. Holmes (veterinary medicine); Mr. G. H. Arthur and Mr. G. C. Knight (veterinary surgery).

University of Birmingham

THE title of emeritus professor has been conferred by the University of Birmingham on Dame Hilda Lloyd, formerly professor of obstetrics and gynæcology, Prof. W. Stiles, formerly Mason professor of botany, and Prof. G. N. Watson, formerly Mason professor of mathematics.

The following appointments in the University have recently been announced: Dr. P. T. Matthews, to be lecturer in mathematical physics; N. A. Dudley, to be lecturer in engineering production; and W. D. Seymour, to be T.I. research fellow in engineering production.

United States Army Medical Library

REFERENCE was made in *Nature* of March 1, p. 355, to the services offered by this institution. We are informed that communications concerning photoprint or microfilm orders should be addressed directly to the Army Medical Library, 7th Street and Independence Avenue, S.W., Washington 25, D.C., and not to the Superintendent of Documen U.S. Government Printing Office, Washington 2 D.C., who deals with the *Current List of Medical Literature* (subscriptions now 9·75 dollars a year and 12·25 dollars a year foreign).

Announcements

THE Institute for the Unity of Science is offering a prize of 500 dollars, with two additional prizes of 200 dollars each, for the best essays on "Mathematical Logic as a Tool of Analysis: Its Uses and Achievements in the Sciences and Philosophy". The competition is open to all and the essays may be written in English, French or German. They must not exceed 25,000 words and must be submitted before January 1, 1953. Further information can be obtained from the Institute for the Unity of Science, American Academy of Arts and Sciences, 28 Newbury Street, Boston 16, Mass.

THE Institute of Archæology of the University of London is organizing seven lectures, open to the public without ticket, on "Archæology and the Natural Sciences", to be held at the Institute, Inner Circle, Regent's Park, London, N.W.1, on successive Wednesdays at 8.15 p.m. commencing April 30. The lecturers will discuss respectively the relationship of archæology with geology, geomorphology, meteorology, plant ecology, metallurgy, agricultural botany and zoology.

THE British Welding Research Association will hold a summer school on "Welding Design and Engineering" at Ashorne Hill, near Leamington Spa, Warwickshire, during July 16–25. The school will be divided into two courses: July 16–20, practical aspects of welding; and July 20–25, design, inspection and manufacturing problems. Further details can be obtained from the Association at 29 Park Crescent, London, W.1.

A BRITISH ornithological conference, arranged by the British Ornithologists' Union and the British Trust for Ornithology, in collaboration with the Monk's House Bird Observatory, will be held at the Pavilion, Bamburgh, Northumberland, during June 26–July 1. A number of excursions will be made to places of interest, including Farne Islands, and six papers will be read. Further details can be obtained from the secretary of the British Trust for Ornithology, 2 King Edward Street, Oxford.

UNDER the auspices of the Midlands Society for Analytical Chemistry, a short symposium on analytical chemistry, dealing with fundamental theory and original methods, will be held in the University of Birmingham during September 10–12, that is, immediately following the International Congress on Analytical Chemistry at Oxford. Further details can be obtained from the honorary secretary of the Society, W. T. Edwards, 100 Rymond Road, Birmingham 8.

THE North-Western Branch of the Institution of Electronics will be holding its seventh annual exhibition of electronic devices at the College of Technology, Sackville Street, Manchester 1, during July 15 (12–9 p.m.), July 16–17 (10 a.m.–9 p.m.) and July 18 (10 a.m.–5 p.m.). In addition to the usual commercial section of the exhibition, there will also be a scientific and industrial research section, incorporating exhibits from research associations and the universities. Admission will be by ticket, obtainable from the secretary, W. Birtwistle, 17 Blackwater Street, Rochdale, Lancs.

ERRATUM. In the article on "Lipid Metabolism" in *Nature* of April 5, p. 569, column 2, line 10 from bottom, for "stigmasterol as an anti-syphilitic factor" read "stigmasterol as the guinea pig anti-stiffness factor".

MOLECULAR ORGANIZATION IN GIANT CHROMOSOMES

By E. J. AMBROSE and Dr. A. R. GOPAL-AYENGAR

Chester Beatty Research Institute, Royal Cancer Hospital, London, S.W.3

THE giant chromosomes, which occur in the salivary glands of many of the Diptera, are considered to correspond to the paired pachytene chromosomes at meiosis. But instead of the two-by-two association characteristic of meiotic prophase these have multiple strands[1]. Moreover, the complication of spiralization is absent in these chromosomes, and they may be said to have entered into permanent prophase. The bands which run across the width of the chromosomes are rich in deoxyribonucleic acid[2]. Schmidt[3] observed weak birefringence in the bands, indicating that the maximum of polarizability was perpendicular to the chromosome length, both in fixed and fresh *Chironomus* preparations.

We have prepared model films of oriented nucleoprotein from herring sperm by stretching the moist material on a rubber base[4]. The rubber was afterwards dissolved away in petroleum ether leaving the nucleoprotein film intact. The infra-red absorption bands due to the nucleic acid component show infra-red dichroism of the kind observed by Frazer[5] in highly oriented fibres of nucleic acid and are negatively birefringent. When placed in 0·14 *M* sodium chloride solution the birefringence and shape of the films are little affected. In distilled water, however, the films show markedly anisotropic swelling as shown in Fig. 1. An expansion of as much as 300 per cent takes place at right angles to the length of the long-chain molecules, with practically no swelling parallel to the chains.

Fig. 1. Film of oriented herring sperm nucleoprotein. Arrow shows direction of long-chain molecules. *a*, shape of film before swelling; *b*, film swollen in distilled water

Similar experiments were carried out with the large chromosomes of *Chironomus* and the relatively much smaller ones of *Drosophila*. The salivary glands were mounted under a coverslip in 0·14 *M* salt solution. An individual chromosome, in an intact nucleus, was selected and photographed, using a phase-contrast system (Fig. 2*a*). Salt solutions of increasing dilution were introduced from the edge of the coverslip, with the chromosome under continuous observation. Fig. 2*b* shows the shape when 30 per cent of swelling had occurred. The chromosomes were allowed to swell after this to such an extent that they became quite imperceptible. But when isotonic salt was reintroduced the chromosomes contracted, practically regaining their original shape (Fig. 2*c*). The ratio of lateral to longitudinal swelling is about 2·5 : 1 for both the *Chironomus* and *Drosophila* chromosomes. The heavily banded regions were more anisotropic than the lightly banded regions. The behaviour of the chromosomes in relation to swelling properties is therefore similar to that of the nucleoprotein films.

The nucleoprotein films can be stained by treatment with a vital dye, neutral red, dissolved in 0·14 *M* salt solution. Such stained films exhibit visual dichroism in polarized light, indicating that the adsorption of dye, on the long-chain molecules, occurs in an orderly manner. The maximum absorption of light occurs with the *E*-vector perpendicular to the chain axes.

A dichroscope, based on the principle of the flicker photometer, has been designed (Fig. 3) to enable

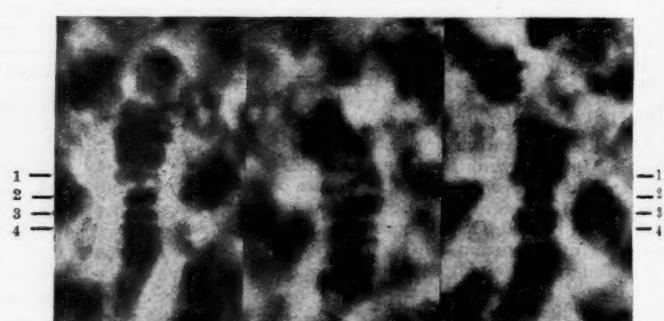


Fig. 2. *Drosophila* chromosome in intact nucleus. *a*, in 0·14 *M* salt solution; *b*, after partial swelling with distilled water; *c*, restored to original shape with 0·14 *M* salt solution. Between (*b*) and (*c*) marked swelling had taken place which made the chromosome invisible

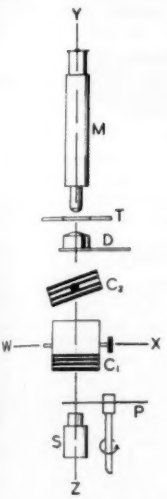


Fig. 3. Flicker dichroscope. *M*, microscope; *T*, stage; *D*, phase-contrast condenser; C_1, pile of glass plates which can rotate about axes *WX* and *YZ*; C_2, similar compensator to eliminate background flicker if necessary; *P*, rotating 'Polaroid' disk; *S*, light source

small amounts of dichroism to be detected in objects just within the resolving power of the light microscope. A compensator (C_1) can be introduced to eliminate flicker in a dichroic object. The position and angle of tilt of the pile of glass plates, in the compensator, give the sign and magnitude of the dichroism. To test whether any dichroism was present *in vivo*, salivary glands of *Chironomus* and *Drosophila* were mounted as before in 0·14 *M* salt solution and observations made on a particular chromosome in an intact nucleus. The vital stain was allowed to diffuse into the chromosomes and, when a sufficient concentration had been reached, flicker was observed in the chromosome. The sign of the dichroism, when compared with the nucleoprotein model, indicated the presence of long-chain molecules lying parallel to the length of the chromosome thread. The dichroism was distinct in the lightly banded regions.

The results of the swelling and dichroism experiments, when combined with the evidence of D'Angelo[6] that the fresh chromosomes can be stretched reversibly up to five times the original length in the nucleus, indicate the presence of an orderly folding of molecules within the chromosome. The structure contains regions with a parallel arrangement of long-chain molecules, recalling somewhat the type of organization found in crystalline globular proteins[7].

Further similar investigations on a variety of animals and plants are in progress.

Mention should be made of two short communications concerning dichroic phenomena which have appeared since completion of the above experiments. Oriented nucleoprotein fibres have been prepared by White and Elmes[8] which show dichroism on staining with toluidine blue and other dyes. Ruch[9] mentions weak ultra-violet dichroism in the bands of *Chironomus* chromosomes. Details about whether the specimen was fresh or fixed and the sign of the dichroism are, however, not given.

We are grateful to Prof. A. Haddow for his interest in this work. We should like to thank Mr. F. E. Speed for his help in the photography, and Dr. M. Bird, who supplied the *Drosophila* larvæ. One of us (A. R. G-A.) is indebted to the Lady Tata Memorial Trust for the award of an International Research Fellowship and to the Atomic Energy Commission, Government of India, for permission to carry out work at the Chester Beatty Research Institute. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Feb. 16.

[1] Koller, P. C., *Proc. Roy. Soc.*, B, **118**, 371 (1935).
[2] Caspersson, T., and Schultz, J., *Nature*, **142**, 294 (1939).
[3] Schmidt, W. J., *Chromosoma*, **2**, 86 (1941).
[4] Butler, J. A. V., and Ambrose, E. J. (in the course of publication).
[5] Frazer, M. J., and Frazer, R. D. B., *Nature*, **167**, 761 (1951).
[6] D'Angelo, E. G., *Biol. Bull.*, **90**, 71 (1946).
[7] Perutz, M. F., *Proc. Roy. Soc.*, A, **195**, 474 (1949). Kendrew, J. C., *ibid.*, **201**, 62 (1950). Elliott, A., and Ambrose, E. J., Faraday Soc. Disc., No. 9, 246 (1950). Carlisle, C. H., and Scouloudi, H., *Proc. Roy. Soc.*, A, **207**, 496 (1951).
[8] White, J. C., and Elmes, P. C., *Nature*, **169**, 151 (1952).
[9] Ruch F., *Exp. Cell. Res.*, **2**, 680 (1951).

A WAR-TIME FISHERY

By Dr. L. HARRISON MATTHEWS
Zoological Society of London

FISH of many species abound in the waters of the Bristol Channel, and fisheries have existed on its shores from prehistoric times. Nearly all the commercial fishing is done on the foreshore with 'fixed engines'—nets and traps of various sorts fastened to stakes and visited by the fishermen at low tide. The great rise and fall of tide in the Bristol Channel makes this sort of fishing possible; the gear is set on dry land and fish are brought to it by the tide.

The fisheries of the Bristol Channel, except the salmon fisheries, have been declining for the past fifty years and have now only a fraction of their former importance. In 1851 it was estimated that the annual value of the fisheries between Burnham-on-Sea and Weston-super-Mare was £10,000; but now the value of the fish taken is too small for inclusion in official statistics. The decline of the fisheries was largely due to the development of the great fishing ports, which send regular supplies of deep-sea fish to all parts of the country, so that the smaller supplies fluctuating with the seasons are crowded out of the market.

In the period between the two World Wars the last remaining fishery of any importance was the swing-net fishery for sprats. Swing-nets are bag- or stocking-shaped nets buoyed and moored in the tideway. The net is extended by two spars at the mouth, the upper one of wood and the lower one of iron which keeps the mouth open by its weight. The spars are made fast by bridles to a mooring line, one end of which is fixed to a chain held on the bottom by two 30-cwt. concrete sinkers; the other end of the mooring line is buoyed at the surface, usually with a cask. The net swings with the tide so that the mouth always faces the stream and fishes both on the ebb and the flood. A tripping line made fast to the lower spar runs to the buoy through a thimble on the upper spar. When the net is visited by the boat at slack water, the tripping line is hauled up, closing the net and bringing it to the surface, and the cod end is brought aboard and emptied. The net is about 40 ft. long and its mouth is 16–18 ft. square. The chief catch of swing-nets is sprats, with variable numbers of whiting, small cod, dabs, flounders, thornback and conger, and some shrimps. The bottom fish are caught while the net fishes near the bottom when the tide runs with its greatest force. The fishing season lasts from early October to the end of January (occasionally a month or six weeks longer).

The swing-nets used in the Bristol Channel are made up by the fishermen from lengths of machine-made netting specially braided to order for this fishery at the factory. The specification is 70/900, hitchings every 2 ft. (between the pieces of machine-made net), seven 4's, one each of 5's up to 20's or more. The net is heavily headed with trawl twine and set in by the third. The tail is straight and 70/70. The mesh increases from 1 in. at the tail to $1\frac{1}{8}$ and $1\frac{1}{4}$ in., finishing with $1\frac{1}{2}$ in. for the last few rounds at the mouth, which measures 21 yd. round. The size of the twine used is No. 20 to No. 15 (local designation). Each swing-net is fished for one week at a time and is then brought ashore for barking with cutch. The life of a net is reckoned at five years, and its pre-war price was about £7–£10. The nets used at spring tides are rather smaller than those used at neaps because the larger net will not stand the great weight of the current at spring tides. Swing-nets were introduced about 1880, and to a large extent have supplanted nets of similar shape set on poles planted in the ground on the foreshore and visited by the fishermen at low tide. They have the advantage of fishing on both ebb and flood, whereas the fixed nets fish only on the ebb.

Swing-nets have been in use at several places on the English coast of the Bristol Channel; but since about 1935 they have not been used elsewhere than at Weston-super-Mare. Most of the men now or recently engaged in fishing are at least middle-aged; they say the younger generation is unwilling to work as hard as the occupation requires. Now that short hours of work and a high standard of living are general, the younger men will not enter this arduous calling, and when they are out of work unemployment benefit supports them so that they are not forced into any work they can find to save themselves from starvation. The calling requires much specialized knowledge in many directions, knowledge that is not picked up casually. The management of boats—some of the fishermen even build their own—the making and setting of nets and so on, are learned only slowly and by experience. Temperament has much to do with making successful fishermen, most of whom have considerable independence of spirit and a liking for the way of life, hard as it is.

The fine mesh of swing-nets takes great quantities of fish too small for the market. The catch of sprats is culled and only the larger fish are marketed, so that a great quantity of undersized sprats, cod, whiting, and flat-fish with small fish such as gobies, pout, poor cod and other unmarketable species is thrown away. The quantities of small cod and whiting 4–6 in. in length were very large during the season 1939–40. It had been the practice to throw away all this mass of undersized fish, with the exception of a limited amount of undersized sprats which were used as garden manure. It appeared possible that these fish might be of some use to the fish-paste industry, and contact was therefore made with a factory in Somerset that was engaged in making preserved foodstuffs. The factory was interested in the proposal to make use of this fish because its normal supplies were curtailed owing to the War.

The usual raw material used as the basis of fish-pastes was canned salmon, which came to the factory ready cooked. The factory thus had no experience of dealing with raw fish, and it was necessary to make experiments to find if it could be used. The bones of canned salmon, which is already cooked, are soft,

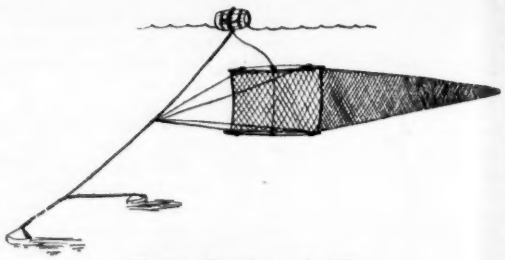


Diagram of a swing-net in action

so that the entire contents of the cans can be ground in mills to form the paste. After the paste is made and packed in pots, it is sterilized in autoclaves with steam under pressure. It seemed possible that the autoclaves might be used for cooking the raw fish; they were tried and the method was successful. The fish were packed on wire mesh trays to a depth of two or three inches, stacked in the autoclave, and given from 10–20 min. cooking at 120° C. This not only cooked the meat but also softened the bones, finrays and scales, so that the cooked fish could be ground in the mill without further treatment. It was found that milling produced a paste of good smooth consistency and excellent flavour. Fish of mixed species could be used, and there was no need for scaling, boning or gutting them. The paste after milling required only the addition of diluent, salt, spices and dye, and a minimum of shrimp or salmon meat. The product was packed in pots, autoclaved, sealed and marketed as "savoury fish paste containing salmon [or shrimp] with other fish".

The factory was put into touch with some of the Weston-super-Mare fishermen, who at once began sending it regular supplies of 'trash'—mixed small fishes of all kinds. The factory offered 10*s.* a cwt. f.o.r. at Weston-super-Mare, and at first took 3 cwt. a day four days a week. When it was shown that the fishing season lasts only for the winter months, the factory increased its consumption and endeavoured to fill part of its summer requirements by storing the fish, both in salt and in cold store. It then took 3 cwt. a day at 10*s.* a cwt. five days a week, and offered 7*s.* 6*d.* a cwt. for any quantity in addition. As a result, it was sent an additional 3–4 cwt. daily at the lower price, an arrangement which appeared to be satisfactory to the fishermen.

The sprat fishery during the winter of 1939–40 was not good; but great quantities of small cod and whiting were taken, together with much other small fish. This new outlet for their formerly useless catches was therefore much appreciated by the men who took advantage of it. Their dealings with the factory were very satisfactory to them; they were paid promptly every week for the weight of fish received by the factory, which tallied with that dispatched. Empties were returned promptly, and a further supply of them was provided by the factory when the quantity of fish taken daily was increased.

This arrangement was completed only towards the end of the 1939–40 fishing season; but in the last few weeks of that season between 12 and 15 tons of fish that would otherwise have been wasted were utilized. The arrangement was maintained in the following years during every fishing season until that of 1949–50, and very considerable quantities of fish were thus used for food. In the season 1948–49, however, the factory reported a considerable falling-

off in the demand for fish pastes, and at the end of the 1949–50 season it cancelled the arrangement. Since that season no further fish from the Bristol Channel swing-net fishery has been used by it for manufacturing purposes.

Even when the arrangement was in full operation, however, the fishermen frequently took larger quantities of fish than the factory could deal with, and the surplus was then sold to a local firm of poultry-food manufacturers. Nevertheless, at the height of most seasons this additional outlet was not able to absorb all the fish caught and the remainder was sold to a firm engaged in boiling pig-swill. The poultry-food manufacturers continued taking supplies until the season 1950–51, when their demand decreased and finally stopped. The remaining outlet, the firm boiling pig-swill, has always been able to take as much as the fishermen wished to dispose of but at very small prices.

Owing to the cessation of demand from the fish-paste factory and the poultry-food manufacturers, the effort put into the fishery in the season 1950–51 was much less than usual; such catches as were made were small and disappointing so that the season was counted a complete failure by the fishermen. The season just past, 1951–52, has also been a complete failure. The few nets put out at the beginning of the season caught practically nothing and the full fleets were not fished at all. A net was set at the beginning of October and was kept fishing on and off until into January; but on no occasion were more than about 10 lb. of sprats landed. The fishermen reported that it was the worst season ever known, and that they are at a loss to understand the reason for it.

The life of the industry thus lasted just ten years, and although the undertaking was never great it helped to eke out food supplies and to vary the monotonous diet of war-time; it was also a valuable source of income to enterprising fishermen. The factories are now able to obtain their raw materials from sources less liable to seasonal fluctuation, materials which, being partly manufactured, need less work done upon them. The ranks of the skilled fishermen are not being filled by younger men; the long, irregular hours of work for uncertain returns are very unattractive in times of full employment when easy work can be obtained by all. The old hands are discouraged by the failure of recent seasons and the lack of demand for their catches, and young men will not consider such hard work. Thus, high freight charges, and the frustration of enterprise by permits and regulations, combined with two very bad seasons, seem to have completed the extinction of this interesting local industry.

THE ORIGIN OF ASTRONOMY

THE George Darwin Lecture of the Royal Astronomical Society was given on April 13, 1951, at Burlington House, London, by Prof. Antonie Pannekoek, professor of astronomy in the University of Amsterdam, on the occasion of the award to him of the Society's Gold Medal for his work in astrophysics and on the structure of the galactic universe. Prof. Pannekoek's lecture, which has now been published*, was on "The Origin of Astronomy".

Starting with primitive astronomy, he said that he believed that the origin of this was not due to the beauty of the silent heavens but to utilitarian motives. He agrees with Schiaparelli that economic necessities were at the root of man's astronomical as well as of his physical and chemical knowledge. Among such necessities there was the need for finding direction by land and sea, and history affords many instances of man using the celestial luminaries to guide him. Even so-called backward races like the Polynesians were well acquainted with the stars, and they steered their vessels by means of the rising and setting of the heavenly bodies. Of even greater importance than for navigation was the application of astronomy for time reckoning, and so crude forms of almanacs came into existence which enabled farmers to regulate their work according to seasonal life-periods of animals and plants; to-day primitive peoples are able to observe solar phenomena, such as the solstices, by noticing the times of extreme rising and setting at points of the horizon marked with stones. The helical rising of certain stars, indicating the time for sowing, just as the helical rising of Sirius in June foretold to the ancient Egyptians the flooding of the Nile, is still used by backward races even if they have come into contact with the white man. The use of the moon as the measure of time among many ancient races is well known, and the sacred books of some of these allege that the moon was created for this very purpose. Although a certain amount of astronomical knowledge characterized prehistoric man, this knowledge was frequently in the hands of old people or priests; but it would be a misnomer to call it astronomical science. Science, in the real sense of the word, arose when man entered into the stage of civilization, and the transition from barbarism to civilization was marked by the invention of script.

About five thousand years ago the first civilizations arose in the fertile plains of Egypt, Mesopotamia, India and China, and in time a strong State power grew up to defend the inhabitants against warlike tribes who found only meagre living in their surrounding mountains and deserts. Thus arose an army to protect the farmers, and beside the military power stood the civil officials; with the appearance of these ruling classes with their wealth and luxury new needs gave rise to developments of refined arts and spiritual culture. In these circumstances the conditions were present for the introduction and spreading of script. The effect of the new conditions on astronomy was far-reaching, because the use of script added enormously to the powers of the priests to whom were entrusted the regulation of time as well as many other important State responsibilities. Ancient inscriptions show the leading part that the priesthood took in settling by means of the heavenly bodies the times of sowing and reaping. Naturally, the work for utilitarian purposes did not end there, and so a number of constellations were recorded and also the brightest of the planets; later astrology arose, though at first it was largely limited to the significance of celestial phenomena for national events—unlike this superstition at present when it is the cult of the individuals who may be more numerous than many astronomers suspect. How did these ancient peoples, Babylonians, Egyptians, Assyrians, etc., without knowing much about scientific aims, build up a scientific theory?

As Prof. Pannekoek shows, this was made possible for astronomy by the occurrence of simple and striking periodicities in the celestial phenomena, and among such phenomena lunar eclipses played a prominent part as their prediction is comparatively

* *Mon. Not. Roy. Astro. Soc.*, 111, No. 4 (1951).

simple. It is fairly certain that various regularities in the movements of the planets were also perceived and resulted in expectations, and ancient Assyrian inscriptions testify to a fairly advanced knowledge of planetary periods. A remarkable change in outlook took place when warring little countries were absorbed in the Persian Empire, because the old astrological omens of lucky for Akkad and unlucky for Elam lost all significance. Then astronomers were no longer ignorant earthlings deciphering from the sky messages for the times, and as a consequence the study of the stars and planets became more precise. Some of the scanty inscriptions of the following centuries of rule by the Persian and the Seleucid kings show that a greatly increased knowledge of the periods of revolution of the planets existed, and ephemerides have been found for different years, up to the beginning of the Christian era. Babylonian astronomy attained a more perfect form of theoretical knowledge in the last century B.C., of which various examples are given, and it presents an admirable system of theoretical knowledge, though it is entirely devoid of any physical interpretation. Even the planets were not solid bodies moving in their orbits but mere luminaries wandering along the firmament with unravelled regularity. The cause of this restricted character was due to the priests, whose astronomical work was service to the gods. A further step was necessary if structural theory is regarded as an essential characteristic of theoretical science, and this step was taken by the Greeks.

The Greeks cannot be said to have been great astronomers if we are to judge them from the amount of their observations and detailed knowledge of the heavenly bodies; but, on the other hand, they developed a geometrical way of thinking as an excellent system of demonstrable truths, and this was fit to become the basis of a future higher state of astronomy. The determination of the relative distances of the sun and moon by Aristarchus affords an example of their attitude towards the heavenly world, dealing with its orbs as objects of geometry. In consequence of the conquests of Alexander the Great and the mergence of the Greek and Oriental world which introduced the Hellenistic era, the Greeks gained access to the observational results of the Babylonians. As a result, it was now possible to fill in their geometrical world scheme by exact data on periods and inequalities, and the outcome was the theory of epicycles in which, Prof. Pannekoek believes, we may be said to have reached our goal—true astronomical science. "There is," he says, "a conception of science which considers only the latest truth as real, true science. It sees the epicycle theory as a primitive erroneous system, to be superseded 1,700 years later by the true world system." Regarding it from the historical point of view, the epicycle theory represents correctly the relative motions of the planets in their circular orbits, only the original assumptions as to the zero point of the motions requiring subsequent corrections. "It is scientific theory in the strictest sense of the word, systematization of observational facts in a world structure suited to the computation and prediction of future events." The study of the history of science—not only of astronomy—shows how important is this stage in the growth of knowledge; though conditioned by the social development of the time, yet as the outcome of observation and thought throughout the centuries, it becomes the starting-point of later progress towards modern science. This affords an explanation of the fact that at a comparatively early time astronomy was able to rise to the high rank of a science when knowledge in other realms of natural phenomena had not risen above the stage of technical experience.

GEOLOGICAL ASPECTS OF CLAY MINERALOGY

A MEETING of the Clay Minerals Group of the Mineralogical Society, held in the apartments of the Geological Society of London, Burlington House, London, W.1, on November 2, 1951, was devoted to a discussion on geological aspects of clay mineralogy. Dr. G. Nagelschmidt (Sheffield) occupied the chair at both morning and afternoon sessions.

Prof. P. G. H. Boswell (Imperial College of Science and Technology, London), in the introductory paper (read in his absence by S. E. Coomber), reviewed the contributions made by clay mineralogists to the study of the diagenesis of sediments. Progress towards the assessment of the character of the clay mineral assemblages in some of the major stratigraphical divisions was summarized, and differences between the results obtained by various workers noted. After discussing the problem of shale formation, Prof. Boswell concluded by outlining some problems, the solution of which awaits more intensive application of clay-mineralogical techniques to geological research. In the discussion, general agreement as to the many problems awaiting solution was expressed, and the contributions which can be made by clay mineralogists were emphasized.

In a systematic petrographic study of the argillaceous rocks associated with the principal sedimentary facies[1], M. Georges Millot (Nancy) has found that kaolinitic minerals are characteristic of the lacustrine or fluviolacustrine continental facies deposited under acid, leaching conditions; that illite is characteristic of the saline lagoonal and basic continental facies, although attapulgite and montmorillonite appear under calcareous conditions; and that the mineralogical composition of the marine facies is very mixed, in accordance with its origin, but, generally, a mixture of micaceous minerals (mainly illite) with kaolinite predominates. Statistical information on the variation of clay mineralogy with medium, with potash content, with *p*H, etc., was given by frequency curves and, in summarizing his results, M. Millot directed attention to the problems which have still to be solved. Dr. H. Greene (Rothamsted Experimental Station), in the ensuing discussion, gave an example in agreement with M. Millot's observation of anomalous formation where conditions of deposition are only broadly defined, while Dr. E. W. Russell (University of Oxford) suggested that montmorillonite might be found in soils derived from the Lower Chalk, but not in those from the Upper. The abundance of kaolinite in the acid continental facies was commented upon by Prof. J. H. Taylor (King's College, London), who suggested that, in view of the work of Grim *et al.* on recent sediments[2], the absence of montmorillonite from ancient deposits might be due to its disappearance at some post-depositional stage. The conversion of montmorillonite into illite solely by pressure was queried by Dr. D. M. C. MacEwan (Rothamsted Experimental Station), while, in the same connexion, the effect of drying on potassium montmorillonite[3] was referred to by Dr. Nagelschmidt.

That changes in the character of the original clay minerals may occur during the three stages in the evolution of sedimentary rocks—deposition, diagenesis and weathering—was pointed out by Prof. Taylor in his review of the recent work on the environmental significance of clay minerals. Some of the outstanding problems were discussed, and Prof. Taylor appealed for more adequate geological data in papers dealing with clay mineralogy. In the discussion, some comments on the occurrence of glauconite were made by I. H. Warren (St. Austell).

In discussing the geochemical significance of deep-sea clays, Dr. J. D. H. Wiseman (Natural History Museum) showed that consideration of the sodium–potassium ratios in igneous rocks, river water, etc., leads to the conclusion that the high sodium content of the sea can be accounted for only by continuous abstraction of potassium. Recent results have demonstrated that, in the fine fraction of deep-sea deposits, potassium predominates over sodium, although chemically this fraction does not correspond with illite. Dr. Wiseman suggested, therefore, that the major part of the abstraction of potassium takes place on colloidal compounds of silicon, aluminium, iron and manganese. Sources of deep-sea clays were discussed and reasons given why the rate of sedimentation has remained constant with time in certain areas of the deep-sea floor. A lengthy general discussion ensued in which many members participated. The relative solubilities of various potassium and sodium salts, the formation of potash deposits, salt conditions in the Dead Sea, etc., were all dealt with, while the material responsible for the abstraction of potassium was commented upon, both by K. Norrish (Rothamsted Experimental Station) and by D. B. Honeyborne (Building Research Station, Garston). The latter suggested that the X-ray oriented-aggregate technique might give further evidence and discussed the possibility of the appearance of intermediate stages in the formation of illite.

The concept of a reaction series to represent the 'weathering' sequence involved in the development of clay minerals from source rocks was developed in a paper by Prof. J. C. Griffiths (Pennsylvania State College), read by S. E. Coomber. The implications of such a sequence lead to similar applications as those of Bowen's reaction series for igneous rocks[4] in terms of crystallization, petrogenesis and aggradational metamorphism. According to this reaction relation, sedimentary rocks and soils are merely halt-stages in a series from igneous rocks to the final common end-product—'laterite'. Reversals in the degradational sequence prior to its culmination are explicable in a manner similar to that used for the formation of low-grade metamorphic rocks from sediments. Some doubt was cast on the degradation of illite to kaolinite by Dr. R. W. Grimshaw (University of Leeds), who reported experiments in which illite had been treated with various solutions in an autoclave, where, in the presence of potassium salts, a reversion to muscovite was observed. His conclusion that illite might be formed from sodium–mica led to further discussion with Dr. Nagelschmidt and Mr. Norrish.

R. H. S. Robertson and A. E. Twedily (Glasgow) described the biogeochemistry of Skye diatomite in which, in addition to diatom frustules, they had found a 'clay material' which, as it gave no X-ray pattern or reaction on differential thermal analysis, they concluded to be an amorphous mixed-oxide gel. The chemical composition of this gel was remarkably constant, and its distribution could be related to water-movement conditions at the time of deposition. The authors concluded that this gel, which on account of its composition they termed 'zeolitic', was in all probability the final stage of the gelatinous, ferruginous compounds which adhere to living diatoms and which consist of the elements in their habitat not required for growth of their frustules. In reply to Dr. Nagelschmidt, Mr. Robertson reported that, for chemical analysis, it is possible to dissolve the 'clay material' without affecting the diatom frustules. Dr. R. C. Mackenzie (Aberdeen) queried the attribution of a definite mineral name to an amorphous co-precipitate the composition of which would presumably vary with environmental factors, while Dr. A. Muir (Rothamsted Experimental Station) suggested the use of the usual term for amorphous materials—'allophane'. Mr. Robertson, in reply, stressed the constancy of chemical composition and the difference in composition between this material and 'allophane' as currently used[5].

The general geology of the Cornwall region, and in particular that of the St. Austell china-clay deposit, was discussed by L. G. Brown (St. Austell). The types of alteration of the granite masses, the typical products of each, and the type of veins pervading the granite were described. After a brief description of the methods used in mining the clay, the different properties necessary to give a good clay for various applications were reviewed. Dr. N. O. Clark (St. Austell) and Mr. Warren both added comments on different aspects of the geology of the deposit. In reply to Dr. MacEwan, Mr. Warren indicated that the 'glauconite' he had described had been identified by X-ray examination; but, in showing a thermogram of the material, Dr. Mackenzie commented upon the resemblance to Ballater illite[6]. Commenting on a question by Mr. Norrish, Mr. Robertson mentioned that, in East Africa and Germany, kaolinite, as distinct from fireclay-mineral, is formed by intense sub-aerial weathering.

In describing the clay minerals present in the Oxford Clay, K. E. Seal (London Brick Co.) showed that, in addition to variation in a vertical direction commensurate with change in the depositional layers, considerable variation in clay mineralogy could be found in any one stratigraphical band, lenses and patches having quite a different composition from neighbouring parts. The investigation has been performed mainly using the differential thermal analysis technique, but this has been supplemented by X-ray determinations carried out in collaboration with Mr. Honeyborne, who reported on some characteristics of the minerals observed. Some comments were made by Dr. Nagelschmidt on the clay-organic complexes postulated by Mr. Seal.

Two brief general papers followed. One, by R. Greene-Kelly (Rothamsted Experimental Station), described an investigation by X-ray and other methods of the clay-organic derivatives of Prof. H. Deuel[7]. Neither with freshly prepared samples nor with some supplied by Prof. Deuel has he obtained a decrease in cation-exchange capacity after esterification and, generally, has been unable to confirm Deuel's results—for example, a reaction reported by Deuel as occurring with benzene was found to be attributable to thiophene. Consequently, considerable doubt arises as to the existence of these derivatives. The other paper, by Dr. V. C. Farmer (Aberdeen), read by Dr. Mackenzie, presented a detailed criticism of the theory of differential thermal analysis proposed by P. L. Arens[8]. Errors both in

the mathematical treatment and in some of the assumptions made were pointed out, and it was concluded that these vitiated the correctness of the theory as a whole. Due to the lateness of the hour, a paper on "Mineralogy and Petrography of the Ordovician 'Metabentonites' and related Limestones", by C. E. Weaver and Dr. T. F. Bates (Pennsylvania State College), was read by title only.

This discussion left little doubt as to the importance of the contributions being made by clay mineralogists to geology, and especially to sedimentary petrology; but the general note was that the problems yet to be solved far exceed those to which present knowledge supplies an answer. A fitting conclusion, therefore, was the plea of Prof. Taylor that clay mineralogists should in all papers supply the fullest available geological data.

R. C. Mackenzie

[1] Millot, G., *Géol. Appl. et Prospect. Minière*, **2**, Nos. 2, 3 and 4 (1949).
[2] Grim, R. E., Dietz, R. S., and Bradley, W. F., *Bull. Geol. Soc. Amer.*, **60**, 1785 (1949).
[3] See Nagelschmidt, G., Imp. Bur. Soil Sci., Tech. Comm. No. 42, 27 (1944).
[4] Bowen, N. L., *J. Geol.*, **30**, 177 (1922); "The Evolution of Igneous Rocks", Chap. 5, 54 (1928).
[5] Wilkinson, P., *Clay Min. Bull.*, No. 4, 122 (1950).
[6] Mackenzie, R. C., Walker, G. F., and Hart, R., *Min. Mag.*, **28**, 704 (1949).
[7] See *Nature*, **168**, 107 (1951).
[8] Arens, P. L., Dissertation, Landbouwhogeschool, Wageningen (1951).

FOOD PROTECTION IN THE UNITED STATES

THE Delaney Committee established in 1950 by the United States Congress is continuing its inquiry into the use of chemical additives in food processing and into the allied problem of the contamination of foodstuffs by residues from pesticides and detergents. The earlier sessions of this Committee[1] revealed that much of the experimental work on the toxicity of chemical additives had given results which were far from conclusive. Biochemists and physiologists in the universities and in food-manufacturing concerns tended to adopt an extremely cautious attitude in their interpretation of these findings; other scientific workers adopted a somewhat different point of view. This division of opinion constituted a challenge to the objectivity of the scientific witness, a challenge which demanded action by an independent body able to discuss the difficult and complex problems in academic calm and with academic freedom.

Thus there came into being in 1951 a Food Protection Committee formed on the initiative of the Food and Nutrition Board of the National Research Council—itself established in 1916 as an offshoot of the National Academy of Sciences for the purpose of providing panels of independent advisers to the United States Government. This Council is representative of more than ninety major scientific societies and includes business men as well as scientific workers and technologists.

The Food Protection Committee has outlined its programme under four headings as follows. (1) It will assemble scientific information on both incidental and intentional chemical additives which are used, or proposed for use, in or on foods and will summarize and evaluate this information and make its conclusions available in usable form to those interested. (2) It will advise and assist industry and Federal and State government agencies in the integration of research on the utilization of chemicals in food production, processing and preservation, and will promote additional research, by existing agencies, which in the opinion of the Committee appears desirable in the public interest. The Committee itself, however, does not propose to conduct or finance research. (3) It will seek to develop guiding principles and standardized procedures essential for safeguarding food. (4) It will encourage and aid in the distribution of accurate scientific information to the general public.

Under the chairmanship of Prof. H. E. Longenecker, dean of the Graduate School of the University of Pittsburgh, the Committee consists of eleven men of science all holding academic appointments in different universities and in different fields—ranging from human pathology and nutrition, through biochemistry and pharmacology to entomology and plant pathology. Four groups have been established (each under the chairmanship of a member of the Committee) to deal with specific inquiries on the following respective subjects: toxicology, pesticides, food technology and chemistry. The groups are composed primarily of men of science in educational posts, with a lesser number drawn from research associations and other bodies. They are assisted by four advisory panels: from industry, from trade associations and research foundations, from government agencies, and from scientific and technical bodies. This relatively complicated structure is designed to ensure, on one hand, objectivity in decisions and, on the other, channels for the presentation of divergent points of view and interests.

A recently published statement[2] of the Food Protection Committee gives a broad survey of the problems under discussion and reveals the efforts being made to provide the equivalent of a pharmacopœia listing the chemical additives in use and their biological effects on experimental animals and on man. This is a project which should prove of permanent value and might well be a fruitful field of international co-operation between scientific workers in Great Britain and their colleagues across the Atlantic.

[1] Aylward, F., *Nature*, **168**, 748 (1951).
[2] Food Protection Committee, "Use of Chemical Additives in Foods" (Nat. Res. Council, 2101 Constitution Avenue, Washington 25, D.C., 1951).

ORIGIN AND DISTRIBUTION OF CULTIVATED PLANTS IN SOUTH ASIA

PLANT breeding in South Asia has in the past largely been limited to selection in local races, which have the great advantage of being closely adjusted by a long process of natural selection to local climatic conditions. Much more than this is now needed. It is necessary to make large collections of both wild and cultivated forms of economic plants, as well as of crossable wild species in the genus. The species itself, and all other species with which it can exchange genes, becomes a gene pool from which desirable combinations can be synthesized by the new techniques now available. The synthesis of new amphidiploids, the induction of advantageous mutations, and the use of embryo culture to make difficult interspecific crosses possible—all these play a part in modern plant breeding.

The evaluation and utilization of a wide range of world material needs considerable knowledge of taxonomy and cytology as well as genetics. Further, the study of the evolution and adaptation of cultivated plants is a separate discipline in itself. It was with the object of surveying existing knowledge of the origin and distribution of cultivated plants in South Asia that the Indian Society of Genetics and Plant Breeding, in association with the United Nations Educational, Scientific and Cultural Organization, held a symposium on this subject in Delhi during January 12–15, 1951. The proceedings of the meeting have now been reported in full in the special "Symposium" number of the *Indian Journal of Genetics and Plant Breeding* (11, No. 1), which has been recently published. In addition to a large number of members of the Indian Society of Genetics and Plant Breeding, the symposium was attended by representatives of other scientific institutions in India and of Unesco, and by delegates from Ceylon, China, Malaya and Pakistan. Profs. E. Anderson, S. C. Harland and A. Müntzing were invited as "expert consultants".

Altogether, twenty-three papers were read, covering a wide range of crops, including rice, wheat, banana, mango, citrus, sugar-cane, millets, cotton and jute. Much new information was presented, and it was evident that the Asiatic countries are for the most part fully aware of the nature and complexity of modern methodology in plant breeding, though they are only occasionally well enough equipped to solve their special local problems.

The participants of the symposium made a series of recommendations for the betterment of plant breeding in South Asia. These emphasized that plant introductions should be made from areas having similar climatic and environmental conditions. The importance of new introductions of plants from Mexico, Peru and Guatemala was stressed. By means of appropriate national or international organizations, the plant resources of the whole area of South Asia should be surveyed, and plant breeding should be accompanied by fundamental work on cytogenetics and physiology in the various botanical research centres.

S. C. Harland

PACIFIC SCIENCE ASSOCIATION

THE Pacific Science Association, which was founded in 1920 and has consistently sought to promote scientific progress in the Pacific, includes as integral parts of its organization the Pacific Science Council, a number of standing committees and the Pacific Science Congresses, of which the eighth is to be held in the Philippines in 1953. The secretariat of the Council has now issued a first report of the Association*, which describes in detail the organization of the Association and its constituent bodies, and its relations with the South Pacific Commission and with the Pacific Science Board of the United States National Research Council; the report also sketches the activities of the Association and its Congresses during the past thirty years as well as, more particularly, the activities of the secretariat during 1950.

Since the constitution and by-laws of the Association are included with the resolutions for research in the Pacific passed at the first seven Congresses and with particulars of the organizing committees and projects appointed for the eighth Congress in 1953, the report constitutes a unique reference handbook on research in this area. The resolutions of previous Congresses are arranged under geology, geodesy and geophysics, volcanology and seismology, meteorology, oceanography, zoology, entomology, botany, conservation, agriculture and soils, forestry, anthropology and social studies, and health and nutrition; they are cross-referenced and are preceded by short accounts indicating the general lines of work and progress made.

The idea of the Pacific Science Association had its origins at meetings earlier than the Pan-Pacific Scientific Congress at Honolulu in August 1920—for example, the Australian meeting of the British Association in 1914, the symposium on Pacific Exploration at the 1916 meeting of the United States National Academy of Sciences, and the conference on international relations at the science-centennial anniversary of the University of California in 1918—and the Pacific Scientific Institution at Hawaii was incorporated in 1907. The Honolulu Congress included sessions on anthropology, biological sciences, geography, geology, seismology and volcanology, and it was resolved that similar conferences should be held at intervals of not more than three years. At the second congress in Melbourne and Sydney in 1923, when the attendance of 101 from nine territories increased to 1,389 from twenty-one territories, and other sections were added, further steps were taken towards a permanent organization with its own central scientific bureau or secretariat, and the present constitution and by-laws were adopted at the third Congress in Tokyo in 1926, when the prefix "Pan" was dropped from the title.

The constitution provides for a Council of ten to fifteen members and a number of standing committees to study the more important problems of common interest and to report on their work at the succeeding congresses. There are at present seventeen such committees; but a permanent secretariat was not established until the seventh Congress, in New Zealand in 1949, and in this Congress the United Nations Educational, Scientific and Cultural Organization played an important part, contributing a subvention of 20 million dollars to enable scientific workers from war-devastated countries in Europe and Asia to be invited. Members from Trust Territories in the Pacific were also represented. Other Congresses were held at Java in 1929, in Vancouver and Victoria, British Columbia, 1933, and in California during July–August 1939.

The seventh Congress, originally scheduled for 1943 in the Philippines, was postponed until 1949, and at this meeting Honolulu was selected as the international headquarters, the secretariat being officially established there in the Bernice P. Bishop Museum on March 20, 1950. The secretariat is assembling a file on current research in the Pacific and has commenced a summary file of scientific expeditions into the Pacific, particularly since 1900, in which the co-operation of scientific workers is invited. The secretariat has also initiated the formation of a Conservation Council for Hawaii and is seeking to establish an epidemiological information centre for the Pacific. It has also handled several specific inquiries from men of science and is issuing an *Information Bulletin* at six-weekly intervals, which is distributed free on request.

* Bernice P. Bishop Museum. Special Publication 41: Report on the Pacific Science Association. Prepared by the Secretariat of the Pacific Science Council. Pp. iii+115. (Honolulu: Pacific Science Council, 1951.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relativity and Indeterminacy

The fundamental postulate of the special theory of relativity, and a vital principle of the general theory of relativity, is that there exists a maximum speed of propagation, confining the link between cause and effect to the surface or interior of the light cone. It is important to realize that, particularly in the special theory, this postulate is used essentially not in the mathematical but in the logical sense. That is to say, it is asserted that causal links and links of information outside the light cone do not exist, rather than that such links are more difficult to describe mathematically than links on or within the light cone. This logical assertion is used to the full in the denial of the possibility of clock synchronization.

It should be pointed out that this logical assertion would be meaningless if a fully deterministic description of Nature were possible. Thus relativity demands a non-deterministic theory such as is given at present by quantum theory. This contradicts the widely held view, repeatedly expressed by Einstein, that there is some conflict between the two theories.

The argument may be stated in the following terms. In a fully deterministic theory there are no uncaused events. Accordingly, an event A need not be considered necessarily as a consequence of an event B (say, on its past light cone); it may equally well be held to be a consequence of the causes of B. Most of these, if not all, will lie well within A's past light cone. In an expanding universe all causes can be traced back so far that an arbitrarily low velocity of propagation of information can be considered sufficient.

Conversely, instead of relating A to B, we may relate it to the consequences of B simultaneous with (or even later than) A. In such a case an infinite or even negative velocity would have to be assigned to the propagation of information. It might be argued that conceivably B might not have any later effects; but the causes of B will have such effects unless the chain of events culminating in B has no connexion with the rest of the universe other than A. In that case A would appear to be uncaused, contrary to the fundamental assumptions of a deterministic theory. Accordingly, no significance whatever can be attached to the expression 'limiting velocity of propagation of cause and effect' in such a theory.

The difficulty is familiar from the attempts to discover the velocity of propagation of gravitation on the basis of general relativity. Any gravitational problem has a solution with fully determined orbits. To suggest that a point on the world line of one particle has a link of special significance with a particular point on the world line of another particle is logically futile. It may be that the link is mathematically somewhat simpler than similar links with other points on the world line of the second particle, but though this could be of some mathematical interest, it is of no logical significance.

However, as soon as, in conformity with experience, we abandon the deterministic framework, the velocity of propagation of caused links becomes definite. The spread of the effects of an *uncaused* event (which was only statistically determined by previous events) has immediate logical significance, and the difficulty mentioned does not arise. Far from relativity being opposed to quantum theory, relativity in fact becomes logically tenable only when the classical picture has been abandoned.

The argument of this communication may be put differently: the flow of time has no significance in the logically fixed pattern of events demanded by deterministic theory, time being a mere co-ordinate. In a theory with indeterminacy, however, the passage of time transforms statistical expectation into real events.

H. Bondi

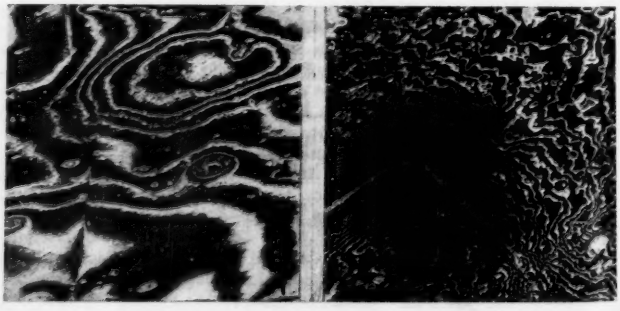
Faculty of Mathematics,
University of Cambridge.
Dec. 24.

Interferometric Studies on Coals

The familiar known correlation between the rank and the reflectivity of coals prompted me some years ago to apply interference methods to the examination of polished coals, and it is the purpose of this brief note to indicate the possibilities of this new approach which I am now making. It can be expected that at least three different features will be revealed by an interferogram of a polished sample of coal. Thus the general topography will largely be determined by the homogeneity or heterogeneity of the material, especially if there exist regions of different resistance-hardness to polishing. Then again, inclusions and cleavages might be expected to reveal themselves. Finally, the local fringe-width will afford a critical indication of local reflectivity and of local mattness.

As examples of what can be obtained by simple methods, Figs. 1 and 2 show Fizeau fringes (with a certain degree of multiple-beam interference) given respectively by a homogeneous anthracite and a heterogeneous ordinary coal. The differences between these two are quite striking. The more homogeneous nature and higher reflectivity of the anthracite is clearly rendered (magnification, × 40).

There is no question that a systematic interferometric survey of coals of known composition is well worth undertaking, and a start in this direction is



(1) (2)

Interference fringes (× 40) from (1) polished anthracite; (2) polished soft coal

being made here with materials kindly supplied by Dr. C. Seyler, of the British Coal Utilization Research Association.

It may be of interest to add that I have obtained reasonable Fizeau fringes from polished hard-woods also.

S. Tolansky

Department of Physics,
Royal Holloway College,
(University of London),
Englefield Green,
Surrey.
Nov. 20.

Lunar Variations in *F2* Region Critical Frequency at Singapore

The existence of large lunar tidal effects in the *F2* region of the ionosphere at latitudes near the magnetic equator has been demonstrated by Martyn[1], and by McNish and Gautier[2], at Huancayo and elsewhere. It was found at Huancayo that minima in the ordinary-ray critical frequency for the *F2* region, *foF2*, occurred at the times of greatest amplitude of the diurnal variation in the earth's horizontal magnetic field, that is, about four days after the new and the full moon.

In this communication, the relation is considered between the midday values of *foF2* at Singapore and the age of the moon over the period from November 1948 to June 1951 inclusive, for which a continuous series of observations was available. As ionospheric conditions at Singapore are noticeably different at the December solstice, the equinox months and the June solstice, it is natural to treat these periods separately. Furthermore, the same periods have been considered in the Huancayo analysis, with which the results obtained from Singapore may be compared. In order to obtain sufficient results for each day of the moon's age, the values of *foF2* at 1100, 1200 and 1300 hr. local mean time were grouped together, and minor fluctuations smoothed out by using three-day running mean values. The results of this superposed epoch analysis are shown in Figs. 1 (*a*), (*b*) and (*c*) for the December solstice, the equinox and the June solstice respectively. A minimum in *foF2* a few days after the full moon is clearly evident at these times of the year, while during the June solstice there is also a well-marked minimum after the new moon. Comparison with the results given for Huancayo[2] shows that the amplitude of the Singapore equinoctial variation for this period near sunspot maximum is approximately half that obtained at the equinoxes at Huancayo during 1941–44, a period near sunspot minimum.

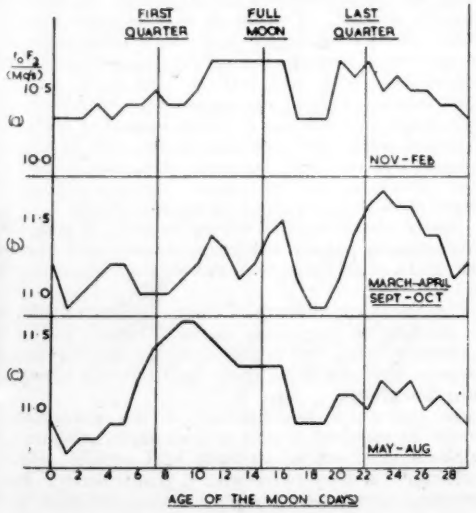


Fig. 1. Lunar variations in f_0F_2 at Singapore at noon (November 1948–June 1951)

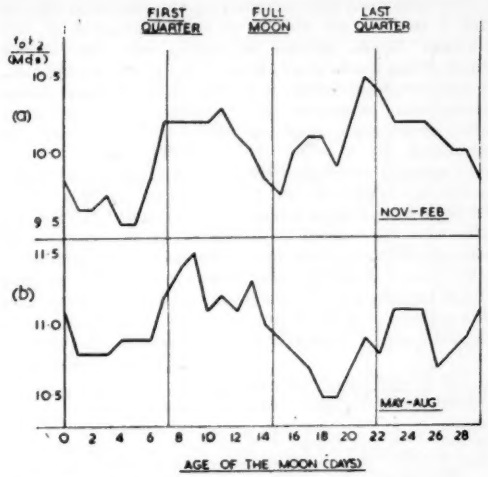


Fig. 2. Lunar variations in f_0F_2 at Singapore at times of maximum thick-layer occurrence (November 1948–June 1951)

A lunar control of the times of appearance of ledges in the upper *F2* region has been suggested by McNish[3]. Ledges in the *F2* region have been observed for several years at Singapore at heights up to about 800 km., particularly before noon during the December solstice and, to a lesser extent, after noon during the June solstice[4]. These ledges are characteristically restricted to periods when a thick *F2* layer is present. In order to ascertain whether the occurrence at Singapore of a thick layer and formation of a ledge were in any way associated with the moon, the values of *foF2* for the three hours centred on 1000 L.M.T. for the December solstice, and centred on 1400 L.M.T. for the June solstice, were examined in a similar manner. It should be mentioned that there was no large diurnal change in the monthly mean values of *foF2* over the hours which were grouped together for the purpose of this analysis. The results obtained are shown in Figs. 2 (*a*) and (*b*) for the December and June solstices respectively. Comparison of Fig. 2 (*a*) with Fig. 1 (*a*) shows that the lunar variation of *foF2* in the December solstice for the hours centred on 1000 L.M.T. is more than twice as great as that obtained at midday, and there is a noticeable minimum after the new moon which was not previously evident. The maxima at the first and last quarters are well marked, and the whole lunar cycle is distinct. For the June solstice, comparison of Fig. 2 (*b*) with Fig. 1 (*c*) shows no significant increase in the amplitude of the lunar component, though the former figure, for the hours after noon, displays a more pronounced full moon minimum.

The data used for constructing the curves in Figs. 1 and 2 include all values of *foF*2 obtained at the relevant hours, except for those very few values which were marked as affected by storm conditions. It may be mentioned, however, that at some hours ionospheric behaviour and conditions of measurement were such that no value of *foF*2 could be tabulated.

It may be concluded that, at Singapore, the moon exerts an influence on the structure of the upper *F*2 region, and thus modifies the value of *foF*2. An adequate theoretical explanation of the very large ionospheric variations produced is not yet available.

The work described above was carried out as part of the programme of the Radio Research Board, and this communication is published by permission of the Department of Scientific and Industrial Research.

B. W. Osborne

Radio Research Station,
Ditton Park, Slough, Bucks. Nov. 28.

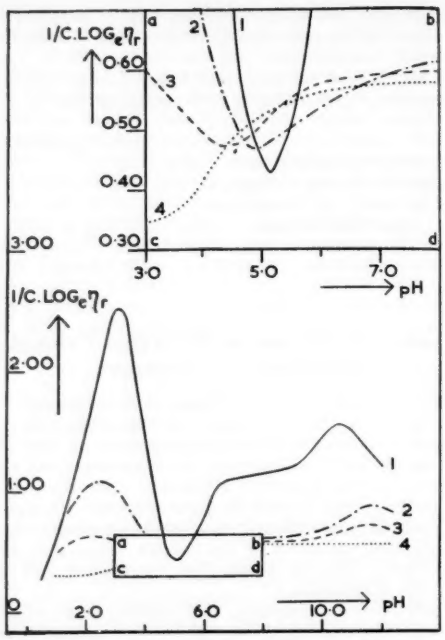
[1] Martyn, D. F., *Proc. Roy. Soc.*, A, **190**, 273 (1947).
[2] McNish, A. G., and Gautier. T. N., *J. Geophys. Res.*, **54**, 303 (1949)
[3] McNish, A. G., Proc. Conf. on Ionospheric Physics, Pennsylvania State College, 1950, Section *CC*, pp. 9, 10.
[4] Osborne, B. W., *J. Atmos. Terr. Phys.*, **2**, 66 (1951).

Viscosity of Dilute Gelatin Solutions

The dilute-solution viscosity method, which has been so successfully used for high polymers, has rarely been employed in studies of protein solutions, even where there is reason to expect a markedly anisodimensional molecular shape[1]. The following results have been obtained on the dilute-solution viscosity of gelatin, as part of a programme of work on the molecular weight and molecular weight distribution. The reduced viscosity $\left(\frac{1}{c}.\log_e(\eta_r)\right)$ of very dilute ash-free[2] solutions of gelatin (gelatin concentration 0·20 per cent and less) have been measured as a function of *p*H (range *p*H 0·50–12·5) and concentration of added electrolyte (range zero to 1·00 *M* sodium chloride) at 35·0° C. in standard U-tube viscometers. The results for an alkali-treated calfskin gelatin of good quality, isoelectric point *p*H 5·08, are given in the accompanying graph.

In principle, the term intrinsic viscosity, as normally defined for uncharged macromolecular systems, may be used only for iso-ionic gelatin solutions or for isoelectric solutions if no preferential combination of the ions from the added electrolyte occurs. In both instances there must be sufficient gelatin present to act as its own buffer. It can be demonstrated, however, that the value of the reduced viscosity at 0·20 per cent concentration is a reasonably good measure of the contribution of the individual gelatin molecules to the solution viscosity for the ranges of *p*H and salt concentration used in this investigation. Such reduced viscosities may, therefore, be regarded as equivalent to intrinsic viscosities for the gelatin molecule in its existing ionic environment.

The family of curves in the graph all refer to a constant average molecular weight, since degradation was not significant. Almost all the features of these curves may then be explained qualitatively on the basis of changes in molecular shape, caused by charged groups. At its iso-ionic point, the gelatin chain configuration is contracted by the attractive forces between the balanced charges along each molecule, together with possible internal hydrogen bonding. If the molecule is regarded as a rigid ellipsoid, the ratio



Reduced viscosity at 35·0° C. as a function of *p*H and concentration of added electrolyte.
Curve 1. 0·2 per cent ash-free gelatin in pure water
„ 2. „ „ „ „ „ „ 0·017 *M* sodium chloride
„ 3. „ „ „ „ „ „ 0·10 *M* „ „
„ 4. „ „ „ „ „ „ 1·00 *M* „ „

of length to diameter is about 25. This follows by substituting the value of the intrinsic viscosity in Simha's equation[3]. The addition of neutral salts to the iso-ionic solution reduces the forces between the charges and leads to some molecular extension.

The addition of acid or alkali to an iso-ionic solution of gelatin leads to the formation of a net positive or negative charge distributed along the chain, as is demonstrated quantitatively by suitable titration curves[4]. The excess charges repel and so cause molecular extension. At the same time, however, the number of free ions in solution (chloride ions from hydrochloric acid and sodium ions from sodium hydroxide in the main) increases and the force between each charge pair is reduced. Thus, increasing addition of hydrochloric acid increases the number of excess charges, but the force between each pair decreases. Each maximum in the reduced viscosity/*p*H curve results from the interplay of these two effects.

Clearly, the addition of neutral salts at, or near, the peaks sharply reduces the forces between each charge pair, and a rapid decrease in viscosity occurs (curves 2 and 3).

The above explanation of the behaviour of gelatin in solution is confirmed by the recent work of Katchalsky[5] for the simpler polyelectrolytes which contain only one or at most two different types of ionizable group.

An important modification of the explanation would be required if ions (for example, calcium or sulphate ions) are so strongly held by the gelatin molecule that they move with it permanently. Preliminary experiments using calcium chloride and sodium sulphate in the place of sodium chloride indicate no conclusive evidence of interference from

this source, in the region of the iso-ionic point.

Other factors not included in the above theory are: (1) the electroviscous effect of Smoluchowski[6]; (2) changes in the *p*K's of the basic and acidic amino-acid residues along the gelatin molecule with changing ionic environment.

It is considered unlikely that (1) would lead to changes of more than a few per cent in the reduced viscosity, although an accurate estimation cannot be made as no satisfactory theoretical treatment is available. In a more detailed analysis of the curves, it is possible that both the displacement of the peaks to more extreme values of *p*H, and the more rounded maxima, when neutral salts are present, are associated with (2).

I should like to express thanks to Mr. A. G. Ward for many helpful discussions during the course of this work.

G. Stainsby
British Gelatine and Glue Research Association,
2*a* Dalmeny Avenue,
Holloway, London, N.7. Nov. 21.

[1] Pouradier, J., and Venet, A. M., *J. Chim. Phys.*, **47**, 11 (1950).
[2] Method of de-ionization: Janus, J. W., Kenchington, A. W., and Ward, A. G., *Research*, **4**, 247 (1951).
[3] Simha, R., *J. Phys. Chem.*, **44**, 25 (1940).
[4] Hitchcock, D. I., *J. Gen. Physiol.*, **15**, 190 (1931).
[5] Katchalsky, A., *J. Polymer Sci.*, **7**, 393 (1951).
[6] Smoluchowski, *Koll. Z.*, **18**, 190 (1916).

Strength of Reinforced Concrete under the Action of Combined Stresses, and the Representation of the Criterion of Failure by a Space Model

In concrete, as in most other brittle materials, two distinct types of failure can be distinguished. A crushing failure is always accompanied by the formation of debris, and is generally caused by diagonal shear due to compression. A cleavage failure is easily recognized by the clean appearance of the fracture; if the concrete is suitably reinforced, failure in direct tension due to bending can be prevented, and a cleavage fracture is therefore normally the result of diagonal tension due to shear.

Leon[1] has proposed Mohr's theory with a single enveloping curve as the criterion of failure for concrete. It is, however, difficult to reconcile the experimental data with this conception without assuming a very sharp change in the curvature of the envelope in the tensile region. There is, moreover, no apparent reason why a single criterion should account for two entirely different types of failure.

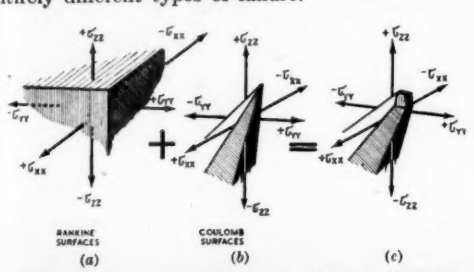


Fig. 1. Space models representing theory of failure for reinforced concrete. (*xx*, *yy*, *zz* represent the three principal stresses, the positive sign denoting tension)

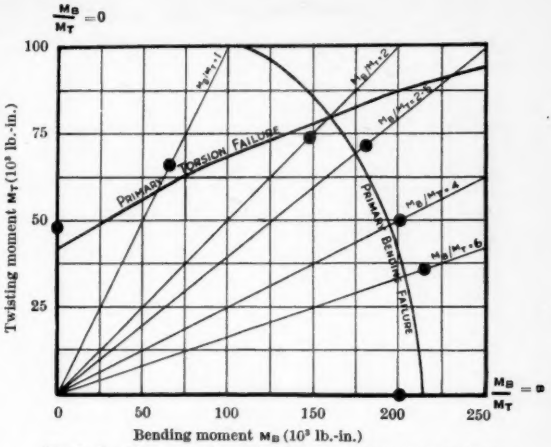


Fig. 2. Bending moments and twisting moments at the breakdown of elastic action. ●, Experimental results

Richart and Brandtzaeg[2] and Balmer[3] have examined the crushing failure of concrete in triaxial compression. Although the envelope of the Mohr circles becomes curved for high triaxial stresses, a straight line inclined to the direct stress axis at the angle of internal friction of the aggregate gives a reasonable approximation in the lower stress range, that is, the range which is of particular interest in the design of engineering structures. The substitution of Coulomb's internal friction theory for the generalized Mohr theory makes it possible to express the criterion for the crushing failure of concrete in simple mathematical terms.

The experiments of Fisher[4] and Nylander[5] in combined bending and torsion generally support the use of Rankine's maximum stress theory as the condition for cleavage failure.

The two theories may be represented by the space models in Fig. 1 (*a*) and (*b*). The combined model in Fig. 1 (*c*) represents the proposed criterion of failure for reinforced concrete under the action of combined stresses.

I have checked this criterion by experiments in combined bending and torsion. Reinforced concrete fails in torsion with a cleavage fracture perpendicular to the direction of the principal tensile stress. In bending, tension failure is prevented, and the beam therefore fails in diagonal shear due to compression. The bending moments and twisting moments of the test specimens at the breakdown of elastic action are shown in Fig. 2, together with the limiting values represented by the surfaces of the model in Fig. 1 (*c*). Primary torsion failure corresponds to the cleavage (Rankine) surfaces of the model, primary bending failure to the crushing (Coulomb) surfaces. An interesting result is the increase in torsional strength resulting from the addition of bending.

Henry J. Cowan
Department of Civil Engineering,
University, Sheffield 1. Nov. 1.

[1] Leon, A., *Der Bauingenieur*, **15**, 318 (1934).
[2] Richart, F. E., Brandtzaeg, A., and Brown, R. L., Univ. Illinois Eng. Exp. Sta. Bull. No. 185 (1928).
[3] Balmer, G. G., U.S. Dept. Int., Bur. Reclamation, Struct. Res. Lab. Rep. No. SP.23 (1949).
[4] Fisher, D., Ph.D. (Civ. Eng.) thesis, Univ. London (1950).
[5] Nylander, H., Statens Kommitté för Bygnadsforsking, Medd., No. 3 (Stockholm, 1945).

The Colouring of Maps

The countries of a map are sometimes given colours in such a way that no two countries which have a common frontier line are coloured the same. Map-makers have long known empirically that four colours are sufficient to colour a map in this way, provided they are distributed correctly. In the nineteenth century, de Morgan and Cayley directed attention to this, and unsuccessful attempts were made to prove or disprove that *any* map drawn on the surface of a sphere or on a plane can be coloured, using at most four colours. This question, known as the four-colour problem, is to-day one of the most famous unsolved problems in mathematics. Heawood[1] has proved that five colours are always sufficient.

When the four-colour problem could not be solved, the colouring of maps drawn on more complicated surfaces than the sphere was considered. Heawood[2] proved that for all $h > 1$, any map drawn on any surface of connectivity h can always be coloured with, at most, n_h colours, where

$$n_h = [3\tfrac{1}{2} + \tfrac{1}{2}\sqrt{(24h - 23)}].$$

($[x]$ denotes the greatest integer not exceeding x. For the sphere and the plane $h = 1$, and substituting $h = 1$ gives $n_1 = 4$.) For $h = 2, 3, 4, 5, 7, 9, 11, 13, 15$, it is known that Heawood's number is the best possible[2], in the sense that for these values of h there are surfaces of connectivity h on which maps requiring n_h colours to colour them can be drawn. For all other values of h greater than 1, n_h is an upper bound for the required number k_h, the number such that there exists a surface of connectivity h on which a map requiring k_h colours to colour it can be drawn; but there exists no surface of connectivity h on which a map requiring more than k_h colours can be drawn. The determination of k_h may be called the map-colouring problem for surfaces of connectivity h.

I have recently been able to improve on this situation. It is convenient to call a map 'critical', if deleting any arbitrarily chosen country from it decreases the number of colours needed for its colouring. Clearly, any map is either critical, or a critical map which needs the same number of colours may be obtained from it by deleting suitably chosen countries. In two forthcoming papers[3], I have proved the following:

(1) For all $h > 1$, a map needing n_h colours to colour it can be drawn on a surface of connectivity h if, and only if, a map consisting of n_h mutually adjacent countries can be drawn on the surface.

(2) For $8 \leqslant k \leqslant n_h$ a critical map drawn on a surface of connectivity h, which needs k colours to colour it, contains at most $6(h - 3)/(k - 7)$ countries.

(1) can be used to decide whether $k_h = n_h$ or $k_h < n_h$ if $h > 1$. It is only necessary to consider the different types of surfaces of connectivity h and to verify whether a map consisting of n_h mutually adjacent countries can be drawn on one of them. (2) enables one to determine k_h in a finite number of steps if $h > 1$, because there is only a finite number of essentially different maps containing not more than $6(h - 3)$ countries.

It follows that, for all $h > 1$, k_h can be determined in a finite number of steps. In a sense, therefore, the problem of map colouring for surfaces of connectivity greater than 1 may be considered solved, and there remains only the four-colour problem. It is this circumstance, that the case $h = 1$ is still unsolved, while all the other, at first sight much more complicated, cases can now be settled, which makes the four-colour problem so very remarkable and interesting.

G. A. Dirac

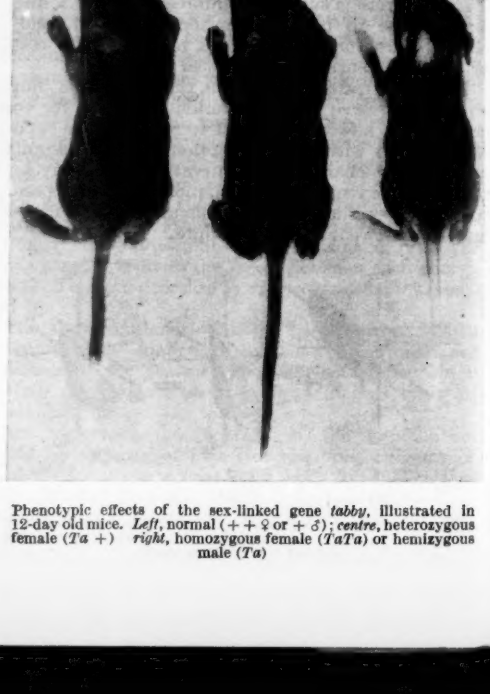
King's College,
London, W.C.2.
Dec. 1.

[1] Heawood, P. J., *Quart. J. Math.*, **24**, 332 (1890).
[2] *Ibid.* Also Hilbert and Cohn-Vossen, "Anschaulische Geometrie", 297.
[3] *Canad. J. Math.*, and *J. London Math. Soc.*, respectively.

A Totally Sex-linked Gene in the House Mouse

The first clearly proved case of total sex-linkage in the house mouse has been found – a fact worthy of record since very few sex-linked genes are yet known in mammals other than man, and none in the rodents. Apart from man, where hæmophilia and colour-blindness are the best known of a number of more or less certainly sex-linked genes[1], there are only yellow in cats[2] and hæmophilia in dogs[3]. In the mouse two genes, *mottled* and *brindled*, have been described[4] which may be totally sex-linked; but this cannot be directly proved as both genes are lethal in males. A test using females heterozygous for the new gene and for *mottled* or *brindled* should settle this point.

The new gene is semi-dominant and behaves in every way as would be expected of a totally sex-linked gene with no homologue on the *Y*-chromosome, though the numbers of mice bred are not yet enough to detect minor deviations from expectation. There are three phenotypes in females, corresponding to the three genotypic classes; but there are only two in males, mutant males resembling the homozygous mutant females. This provides *prima facie* evidence of the existence of a differential segment in the sex chromosome of the mouse. The



Phenotypic effects of the sex-linked gene *tabby*, illustrated in 12-day old mice. *Left*, normal (+ + ♀ or + ♂); *centre*, heterozygous female (*Ta* +) *right*, homozygous female (*TaTa*) or hemizygous male (*Ta*)

three phenotypes are illustrated in the accompanying photograph. Heterozygous females have transverse black stripes reminiscent of the tabby markings of cats, and for this reason the gene is named '*tabby*' (symbol *Ta*). Homozygous females and hemizygous males have a number of abnormalities resembling in every way those produced by the autosomal recessive gene *crinkled*[5,6]. Though the different modes of inheritance prove the two genes to be at different loci, a direct test of allelism is being made.

The remarkably exact and detailed reproduction of the same complex syndrome by two different genes is of more general interest than the fact of sex-linkage. It argues forcibly in favour of the 'principle of unity of gene action'[7], and it provides a laboratory parallel to the situation frequently met with in human genetics, where the same clinical condition behaves as if sex-linked in some pedigrees and autosomal in others[1].

The evidence that *tabby* is sex-linked is briefly as follows. The gene arose by spontaneous mutation and was first observed in a single male which had the 'pseudo-crinkled' phenotype. Mated to normal females, this male produced twenty-nine daughters all with the 'tabby' phenotype, and thirty-eight sons, all normal. These tabby females mated to unrelated normal males produced thirteen tabby and nine normal daughters, seven pseudo-crinkled and eleven normal sons. A tabby female mated to the original pseudo-crinkled male produced four pseudo-crinkled and four tabby daughters, two pseudo-crinkled and six normal sons.

D. S. Falconer*

Institute of Animal Genetics,
Edinburgh.
Feb. 12.

* Agricultural Research Council, Scientific Staff.

[1] Gates, R. R., "Human Genetics" (New York, 1946).
[2] Doncaster (1912); Bamber (1927). Cited by Searle, A. G., *J. Genet.*, **49**, 214 (1949).
[3] Hutt, F. B., Rickard, C. G., and Field, R. A., *J. Hered.*, **39**, 3 (1948).
[4] Fraser, A. S., Sobey, S., and Spicer, C. C., *J. Genet.* (in the press).
[5] Auerbach, C., and Falconer, D. S., *Nature*, **163**, 678 (1948).
[6] Falconer, D. S., Fraser, A. S., and King, J. W. B., *J. Genet.*, **50**, 324 (1951).
[7] Grüneberg, H., *J. Genet.*, **45**, 1 (1943).

Production of Congenital Defects in the Offspring of Pregnant Mice Treated with Compound *F*

It has previously been shown[1] that cortisone, injected into pregnant mice, will produce cleft palates and other congenital malformations in the resulting offspring. The incidence of cleft palate was found to vary with the genetic constitution of the treated mice, the dosage of cortisone used, and the gestational stage at which treatment was begun.

In view of the evidence that compound *F* may be the substance produced by the adrenal cortex in response to stimulation by adrenocorticotrophic hormone[2], it seemed desirable to know whether this compound would have teratogenic effects similar to those of cortisone when injected into pregnant mice. Accordingly, pregnant females of stocks previously shown to be susceptible to the teratogenic effects of cortisone[1] were injected at susceptible stages of gestation with compound *F* (17-hydroxycorticosterone acetate, Merck). Cleft palate (without cleft lip) has not been observed in any offspring of untreated females of these stocks.

Five pregnant females, each injected intramuscularly with four daily doses of 2·5 mgm. of compound *F* starting on the tenth or eleventh day, gave birth to a total of 25 offspring. Of these offspring, five were partially eaten before the state of the palate could be determined. Of the twenty whose heads were examined, nineteen (95 per cent) had median, post-alveolar clefts of the palate. Nine of these were born alive. No external abnormalities were seen by macroscopic examination in any offspring of treated females.

It thus appears that compound *F* and cortisone have similar effects on the development of the embryonic mouse palate.

We wish to acknowledge the financial aid of the National Research Council of Canada, and the Kate E. Taylor Fund of the Banting Research Foundation. Dr. J. H. Laurie of Merck and Co. kindly supplied specimens of compound *F*.

H. Kalter
F. C. Fraser

Department of Genetics,
McGill University,
Montreal.
Jan. 3.

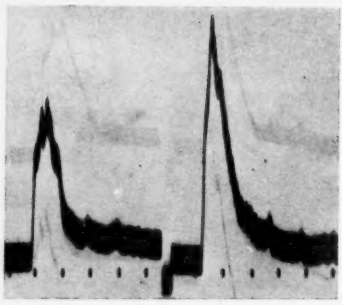
[1] Fraser, F. C., and Fainstat, T. D., *Pediatrics*, **8**, 527 (1951).
[2] Conn, J. W., Louis, L. H., and Fajans, S. S., *Science*, **113**, 713 (1951).

Luminescent Responses in *Chætopterus* and the Effects of Eserine

Animal luminescence comprises two broad categories, namely, those in which light is produced by the animal, and those in which it is due to symbiotic bacteria; but in either event it may be under the control of the animal. The emission of light would then be a significant indication of the progress of underlying physiological events, and by quantitative recording should provide information about the physiology of luminescent effectors. Considerations of this kind have prompted a study of the physiology of light production in the polychæte *Chætopterus variopedatus*. This is a well-known luminescent worm about 10 cm. long that discharges a luminescent secretion from definite circumscribed glands in certain regions of the body[1]. The glandular cells responsible are elongated eosinophilic elements packed with a paraplasmic mass of secretory granules, and when animals are excited and killed simultaneously by dropping into a fixative, the photogenic cells are caught in the act of secreting, and have the appearance of squeezing forth their contents[2].

Although weak, the luminescent response of *Chætopterus* has been recorded with the use of a photomultiplier cell, galvanometer or oscilloscope, and camera. Preliminary studies have shown that the luminescent response in *Chætopterus* is under nervous control[3]. With electrical stimulation it has been found that a single impulse evokes a bright response, and, furthermore, that the intensity of response can be increased by raising the frequency or increasing the number of impulses. The results obtained have many analogies with neuro-muscular functioning, and can be interpreted as due to the activity of contractile units effecting evacuation of the photogenic glands.

Chemical transmitters have been implicated in the responses not only of muscles, but also of glands and chromatophores, and it seemed of value to investigate this problem in connexion with the luminescent



Galvanometer records of the luminescent response of *Chætopterus* under electrical stimulation. The upward deflexion on the left represents the response of the photogenic glands of segment XII freed of nerve cord. The deflexion on the right is the response of the same preparation after treatment with eserine (1/10,000) for 30 min. Stimulation, 0·2 sec. burst at 33 per sec. Time-scale below, 1 per min.

response in *Chætopterus*. It was found that acetylcholine (1/1,000, 1/10,000) evoked usually brief and faint flashes in some animals, bright flashes in others, and the results were very variable. Eserine (1/10,000) definitely augmented the light response to electrical stimulation (see record). Neither atropine nor curare (*d*-tubocurarine) abolished the response to electrical stimulation. There are previous reports that eserine increases the sensitivity of ctenophores to mechanical stimulation[4], and that adrenaline causes the photophores of the teleost *Porichthys* to lighten[5]. The positive results with eserine and acetylcholine obtained in the present investigation suggest that the nerve fibres to the gland cells are cholinergic and implicate acetylcholine as a chemical transmitter in the luminescent response. The non-effectiveness of atropine and curare finds parallels in other invertebrates which have cholinergic fibres insensitive to these drugs[6].

J. A. Colin Nicol

The Laboratory,
Marine Biological Association,
Plymouth.
Nov. 27.

[1] Bonhomme, C., *Bull. Inst. Océanogr. Monaco*, No. 843 (1943). Krekel, A., *Z. wiss. Zool.*, **118**, 480 (1920). Panceri, P., *Atti R. Accad. Napoli*, **7**, No. 1 (1878). Trojan, E., *Sitz. Berich. Akad. Wiss Wien*, **122**, 565 (1913).
[2] Nicol, J. A. C., *J. Mar. Biol. Assoc.*, [**30**, 417 (1952)].
[3] Nicol, J. A. C., *J. Mar. Biol. Assoc.*, [**30**, 433 (1952)].
[4] Chase, A. M., *Biol. Bull.*, **81**, 296 (1941).
[5] Greene, C. W., and Greene, H. H., *Amer. J. Physiol.*, **70**, 500 (1924)
[6] Nicol, J. A. C., *Physiol. Comp. Oecol.* (in the press).

Delayed Toxicity of Certain Trypanocidal Drugs in East African Zebu Cattle

In a series of experiments during the past eighteen months, the trypanocidal drug 2 : 7-diamino-9-phenyl-10-methylphenanthridinium bromide ('Phenanthridinium 1553', 'Dimidium bromide') has been shown to produce a specific toxicity in native cattle at Kabete, Kenya. A syndrome developed between thirty-five and fifty days after inoculation, characterized by loss in weight and condition, a positive direct van den Bergh reaction with clinically observable jaundice in some cases and elevated serum alkaline phosphatase. A periportal fatty infiltration of the liver was found in biopsy and necropsy material. The symptoms of 'photosensitization' already described by other workers and which, although of such spasmodic occurrence, are nevertheless of economic importance in East Africa, have developed in only four of more than a hundred experimental animals inoculated and kept at Kabete. The liver toxicity has been observed regularly at dosage-levels of 2 and 3 mgm./kgm. body-weight given subcutaneously, intravenously or intramuscularly. Doses of 1 mgm./kgm., which is the usual therapeutic level, were occasionally toxic. Larger doses subcutaneously or repeated smaller dosage intravenously produced the same syndrome or loss in weight from thirty days after inoculation, death occurring about fifty days after inoculation, without definite changes in serum bilirubin or alkaline phosphatase but with a massive fatty infiltration involving the whole liver lobule.

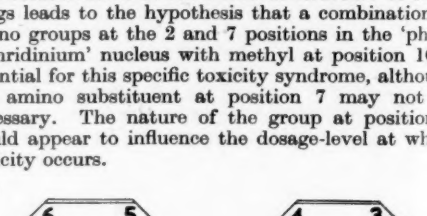
The specific lesion has also been produced by two other phenanthridinium compounds, and their order of potency in this respect appears to be :

2 : 7-diamino-9-*p*-aminophenyl-10-methylphenanthridinium chloride >
2 : 7-diamino-9-phenyl-10-methylphenanthridinium bromide ⩾
2 : 7-diamino-9-α-thienyl-10-methylphenanthridinium bromide.

Four other phenanthridinium compounds, however, have not so far produced any delayed toxic manifestations at the following dosages : 7-amino-9-*p*-aminophenyl-10-methylphenanthridinium chloride up to 8 mgm./kgm. ; and 2 : 7-diamino-9-phenyl-10-ethylphenanthridinium bromide, 2 : 7-diamino-9-phenyl-10-allylphenanthridinium bromide and 2 : 7-diamino-9-phenyl-10-propylphenanthridinium bromide up to 3 mgm./kgm. body-weight.

Administration of antrycide methyl sulphate caused severe delayed toxic sequelæ at 7·5 mgm./kgm. and 10 mgm./kgm., but the latent period was of the order of two to three weeks and the main site of pathological change was the kidney.

A consideration of the chemical structure of these drugs leads to the hypothesis that a combination of amino groups at the 2 and 7 positions in the 'phenanthridinium' nucleus with methyl at position 10 is essential for this specific toxicity syndrome, although the amino substituent at position 7 may not be necessary. The nature of the group at position 9 would appear to influence the dosage-level at which toxicity occurs.



We have furthermore suggested[1] that the effect is due to interference with biological methylations by the methyl-substituted quaternized nitrogen atom, and the inefficacy of the other alkyl groups is evidence in support of this hypothesis.

The failure to produce photosensitization or evidence of delayed toxicity in laboratory animals[2] or bovines[3] in Great Britain suggests that the inter-

ference with metabolism occurs in the bovine only in certain parts of Africa.

M. L. Burdin
W. Plowright

Veterinary Research Laboratory,
P.O. Kabete,
Kenya.
Jan. 12.

[1] Burdin, M. L., and Plowright, W. (in the press).
[2] Brownlee, G., Goodwin, L. G., and Walls, L. P., *Vet. Rec.*, **59**, 518 (1937).
[3] Carmichael, J., *Vet. Rec.*, **62**, 257 (1950).

Preliminary Observations on a Repellent for Terrestrial Leeches

Incidental to studies on the natural history of leptospirosis and scrub typhus, members of a joint U.S. Army–British Colonial Office Research Team, operating recently under field-conditions in North Borneo, noted that a new U.S. Army repellent (*M*-1960), used for impregnating clothing against mites, mosquitoes and fleas, was exerting a highly repellent effect against terrestrial leeches. This repellent, developed by the United States Department of Agriculture, in a project financed by the Department of the Army, is being made a standard item of issue for the U.S. Army and is known as "Repellent, insect, clothing-treatment, *M*-1960". It consists of equal parts of N-butyl acetanilide, 2-butyl-2 ethyl-1,3-propanediol, and benzyl benzoate, with 10 per cent of emulsifying agent ('Tween 80'). One gallon of the concentrate is enough to treat 28 uniforms after emulsification. Preliminary observations on its effect on leeches are reported here.

Depredations of land leeches of the genus *Hæmadipsa*, especially *H. zeylanica* (Moquin-Tandon), are well known to travellers in the mountains of South-East Asia. Many harrowing accounts of these have been published, and some of the more interesting reports have been cited by Stammers[1]. Dozens of leeches may attach themselves undetected to one's person and blood may flow for as long as thirty minutes from the site of attachment. Far more important, however, are the ulcers, abscesses and cellulitis which develop as the result of secondary bacterial infections of the bites. These often heal with difficulty, and may be so severe that they are incapacitating.

British and American troops, operating in the jungles of India and Burma during the Second World War, soon learned that dimethyl-phthalate (DMP), which was issued for protection against chiggers, was fairly effective against land leeches. Experimental results reported by Ribbands in 1946 [2] substantiate these observations. Unfortunately, this compound has disadvantages in that it tends to produce sensations of burning when applied directly to the skin, especially on cut and abraded surfaces and on the more sensitive areas, such as the genito-urinary regions and conjunctivæ. Regardless of its irritating effect, it was necessary to use this compound to remove a leech lodged in the urethra of a soldier in Malaya[3].

Hæmadipsa zeylanica was abundant on the slopes of Mt. Kinabalu in North Borneo in July 1951, particularly between the elevations of 4,000 ft. and 7,000 ft. All the aboriginal Dusuns, who inhabit the area and who habitually go about barelegged, bore sores associated with former leech bites. Almost invariably, when a group of natives was encountered, blood could be seen welling from recent bites on many of them. Secondarily infected bites, particularly ulcers on the legs, with variable degrees of accompanying cellulitis, were the most common complaints of Dusuns appearing for medical attention. In marked contrast to the unprotected Dusuns, it was noted almost immediately that members of the research team were never bothered by leeches while wearing clothing impregnated with *M*-1960 during the field-operations on the slopes of Mt. Kinabalu. At Lumu Lumu (elevation 6,500 ft.), *Hæmadipsa* was particularly abundant and, despite constant vigilance on the part of the porters, leeches became attached to them and at times as many as fifteen were observed per individual. Wearing untreated socks and trousers did not appreciably decrease the incidence of attachments. In fact, the additional clothing made it more difficult to detect the leeches prior to engorgement. Simple experiments were then conducted to ascertain if subsequent more exhaustive tests on *M*-1960 as a leech-repellent were warranted. The pressure of other duties and the small personal supply of treated clothing available greatly limited the scope of these experiments.

Two Dusuns, furnished with untreated Army shoes but with socks and trousers impregnated with *M*-1960, remained free from leeches after walking for half an hour in vegetation observed to harbour leeches; in contrast, two other Dusuns, who served as control subjects and wore their normal attire, that is, shirts and shorts, each had about thirty attached leeches. One Dusun was given an outfit consisting of one leg from a treated set of trousers and one from an untreated set. The corresponding socks were impregnated and non-impregnated. After fifteen minutes exposure, the leg encased in protected clothing remained free of leeches, whereas eighteen were found on the other.

The markedly repellent effect of treated trousers could be completely nullified by covering them with a set of plastic leggings. Exposure for ten minutes in infested areas resulted in fifteen to twenty leeches crawling on the plastic surfaces.

Leeches were frequently observed along the forest trails with one end of their bodies attached to vegetation and the other waving about restlessly. Such leeches would immediately transfer themselves to bare skin or ordinary clothing within their reach. However, they made no attempt to attach themselves to cloth treated with *M*-1960. Leeches dropped on such material would travel at a greatly accelerated pace, making no effort to attach themselves, or would move so violently as to fall off immediately.

Treated clothing washed four to five times with soap in cold water or worn during and after heavy rains still retained effective repellent action toward leeches.

At no time did the repellent *M*-1960 cause any irritation of the skin, or other toxic manifestations under these field conditions.

These limited observations indicate that clothing impregnated with the compound designated by the Quartermaster, U.S. Army, as "Repellent, insect, clothing-treatment, *M*-1960", effectively repels land leeches (*Hæmadipsa zeylanica*) in North Borneo. Plans are being made for a second British Colonial Office–U.S. Army Team to return to Borneo to conduct more extensive tests in this regard.

The field-work described in this communication was possible only through the co-operation of officials

of the Colony of North Borneo, particularly Dr. W. L. Neal, director of Medical Services, and Mr. Rex Blow, district officer at Kota Belud.

This investigation was supported in part by the Commission on Immunization of the United States Armed Forces Epidemiological Board and by the Colonial Development and Welfare Research Scheme No. *R*177, etc.

Robert Traub
Charles L. Wisseman, jun.
Army Medical Service Graduate School,
Army Medical Center,
Washington 12, D.C.
J. R. Audy
Scrub Typhus Research Unit,
Institute for Medical Research,
Kuala Lumpur, Malaya.
Dec. 4.

[1] Stammers, F. M. G., *Parasit.*, **40**, 237 (1950).
[2] Ribbands, C. R., *Ann. Trop. Med. and Parasit.*, **40**, 314 (1946).
[3] Blyth, R. I. K., *Brit. Med. J.*, (ii), 1058 (Nov. 4, 1950).

Feeding Value to Poultry of Grass Leaf Protein

Great Britain is short of protein-rich feeding-stuffs; also they are expensive. Laboratory-extracted leaf protein has been shown to contain a useful content of the essential amino-acids[1,2]. The largest immediate source of leaf in Great Britain is the grasslands. Grass leaf when eaten by ruminants is converted into animal products; but this process is slow and very wasteful. Pigs and poultry make only limited use of grass-leaf protein because of their inability to digest the fibre in grass.

Work is in progress at the Grassland Research Station to develop a large-scale method of extraction of leaf protein and make a product free from fibre[3]. The process involves the precipitation of the heat-coagulable proteins from the juice squeezed from the macerated herbage. The precipitate is separated by filtration and then dried and ground to a powder. The dried material used in the experiments described here contained 5–8 per cent nitrogen, 1–2 per cent crude fibre and 5–10 per cent ash. The feeding trials (unpublished) compared a mash composed of a basic cereal mixture supplemented with leaf protein, with a mash containing the same cereal mixture plus fish meal. The two mashes were made as similar as possible with regard to minerals, vitamins and other factors.

Table 1. Egg-laying Trial of 10 Weeks Duration

Feed treatment	% Crude protein in mash	Average number of eggs per bird	Average weight of eggs per bird (in oz.)
'Leaf protein' mash	16·9	38·8	86·2
'Fish meal' mash	19·4	37·7	87·4

When fed on the two mashes, two groups of six pullets showed no difference in either egg-production or in body-weight. Eggs from the birds fed on the leaf-protein mash had greenish albumen, and if stored these eggs would have developed green yolks[4].

At four weeks of age the live-weight gain of sixty chicks fed from one day old on the 'leaf protein' mash was significantly lower than the gain of sixty similar chicks fed on the 'fish meal' mash. From four weeks, all the chicks were fed on a commercial 'grower's' ration, and the 'fish meal' reared chicks came into lay one to two weeks earlier.

Table 2. Chick Trial 1. (Pullets and Cockerels)

Feed treatment	% Crude protein in mash	Mean live-weight (gm.) at age 3 days	31 days	Mean live-weight gain (gm.) per 100 gm. crude protein eaten
'Leaf protein' mash	16·0	36·1	163	2·11
'Fish meal' mash	20·2	38·6	207	1·95

Table 3. Chick Trial 2. (Cockerels)

Feed treatment	% Crude protein in mash	Mean live-weight (gm.) at age 1 day	28 days	70 days	Mean live-weight gain (gm.) per 100 gm. crude protein eaten
'Leaf protein' mash	16·8	39·0	165	575	1·28
'Fish meal' mash	20·2	38·5	230	704	1·63

In a second chick trial, each ration was fed to three groups of twenty-five 'day-old cockerels'. At four weeks the mean difference of gain in weight was significant (Table 3) and confirmed the earlier trial. When adjustment is made for the difference in the mean weights at the start of the experiments and for the difference in the crude protein percentage in the two rations, all the live-weight gains are of the same order as those reported for other chick mashes[5].

However, at the end of the second chick trial, when the chicks were ten weeks old, the difference in the gain in weight was not significant. The early advantage of the fish meal mash was not being maintained[6]. Work is now in progress feeding pullets from one day old to the end of their first laying period on the two rations.

The results suggest that grass leaf protein can be a useful protein concentrate in poultry feeding, if the mash is supplemented with vitamin B_{12} and balanced for minerals. It may be found necessary to add an essential amino-acid to improve the biological value. There is evidence[7] suggesting that grass protein may be deficient in methionine. The chlorophyll could be extracted, as it has commercial uses. The feeding of the extracted leaf protein should then not produce eggs with green yolks.

Work is in progress in the agronomic and biological fields on problems requiring further investigation. For example, the dried protein may have a digestibility and feeding value lower than that of the freshly precipitated material. Improved methods of cutting and collection of herbage to reduce soil contamination, and hence the ash content of the product, are being developed. A study is being made of the leys and other forage crops which will produce the highest yields of extractable protein.

Dudley E. Eyles
Grassland Research Station,
Stratford-on-Avon.
Dec. 21.

[1] Pirie, N. W., *Chem. and Indust.*, **61**, 45 (1942).
[2] Chibnall, A. C., "Protein Metabolism in the Plant" (Oxford Univ. Press, 1939).
[3] Pirie, N. W., *Food Manuf.*, **22**, 493 (1948).
[4] Davies, A. W., 9th World Poultry Congress, 1951, **4**, 20 (1951).
[5] Halnan, E. T., *J. Agric. Sci.*, **32**, Pt. 2, 179 (1941).
[6] Carpenter, K. J., and Duckworth, J., 9th World Poultry Congress, 1951, **2**, 18 (1951).
[7] Michell, H. H., and Block, R. J., *J. Biol. Chem.*, **163**, 599 (1946).

Egg Production of Pullets Fed on a Ration containing Aureomycin

ANTIBIOTICS and 3-nitro-4-hydroxyphenylarsonic acid have been reported by various workers to stimulate the growth of chicks when added to their rations in low concentrations. Most of these experiments covered only the first four to twelve weeks of life, and male chicks were generally used. In short-term experiments, the addition of aureomycin to the ration of growing pullets enhanced the response of serum calcium and serum riboflavin to injected œstrogens, and it was suggested that the response of endogenous œstrogens might be similarly affected[1].

The present investigation was designed to test whether aureomycin would have a stimulating effect on early growth when the ration was of the type commonly used in Great Britain, and whether, if the supplement continued to be fed, egg-production and egg-size would be affected. In order to provide conditions supposed to favour the aureomycin effect, the levels of animal protein sources in the rations were reduced but not eliminated, while the level of total protein was raised above that commonly employed. A strain of Buff Rock birds with a tendency to broodiness was used. It might be supposed that any hormonal influence of aureomycin on egg-production might be intensified in such a strain.

Day-old chicks were housed intensively and allotted at random to six groups, each of fourteen chicks. They were fed *ad lib.* on the rations shown in Table 1. Three groups received the rations shown according to age, and with aureomycin supplements. The remaining three groups received the same rations without the antibiotic supplements. A commercial aureomycin concentrate ('Aurofac') was used in the laying ration. This has been reported to be as efficient a growth-stimulant for chicks as the pure antibiotic, fed at an equivalent level[2]. Full experimental details will be described elsewhere as part of a series of reports on the vitamin and amino-acid requirements of birds[3].

Experimental results are given in Table 2. Birds fed on the 'antibiotic' starting ration were 18 per cent heavier at six weeks of age than birds fed on the unsupplemented ration, a highly significant difference of the same order as reported by workers using maize–soyabean rations of the American type. By forty-two weeks of age, the birds fed on the unsupplemented rations had caught up in body-weight with those that had been receiving aureomycin.

Table 1. COMPOSITION OF RATIONS FED AT DIFFERENT AGES

Component	Starting ration (0–6 weeks)	Growing ration (7–23 weeks)	Laying ration (24 weeks onwards)
Yellow maize meal	30	20	15
Sussex ground oats	—	11	14·5
Ground wheat	—	—	10
Ground barley	19·5	20	12
Weatings	17·5	20	20
Dried grass meal	5	5	10
White fish meal	2·5	—	2·5
Dec. ext. groundnut meal	21·5	19	9·5
Limestone	1	2	3
Bonemeal	1·5	1·5	2
Salt	0·5	0·5	0·5
Cod liver oil	1	1	1
Riboflavin (mgm./100 gm.)	(0·07)	—	—
Total Crude protein (%)	100 21	100 18	100 16
For supplemented rations only, aureomycin hydrochloride (%)	0·01	0·002	0·001*

* Fed in the form of 0·25 per cent 'Aurofac', a commercial aureomycin concentrate.

Table 2. EFFECT OF AUREOMYCIN ON GROWTH, EGG PRODUCTION AND BROODINESS OF PULLETS

	Unsupplemented rations	Rations containing aureomycin
Live-weight at 6 weeks of age	382 gm.	453 gm.
Live-weight at 12 " " "	1,165 "	1,265 "
Live-weight at 21 " " "	1,821 "	1,962 "
Live-weight at 42 " " "	2,394 "	2,403 "
Egg-production		
1. Mean age at which 5th egg was laid	28th week	28th week
2. Mean egg production—24–64 weeks	137	127
3. Mean egg-weight	58·0 gm.	57·8 gm.
Broodiness		
1. Mean number of days broody	10·4	11·1
2. Mean number of times broody, per bird	1·24	1·85

Sexual maturity, as gauged by the age when the fifth egg was laid, was not advanced by the accelerated growth-rate. Egg production was 7 per cent less in the groups receiving aureomycin during the first forty weeks of laying; but the difference was not significant. Increased body-weight at the onset of egg-laying did not lead to the laying of larger eggs. The addition of aureomycin to the rations did not result in a more efficient utilization of feed calculated in terms of growth up to twenty-one weeks of age, or subsequent egg-production. Mortality was low (six out of eighty-four birds) and not significantly different on the two sets of rations.

The average periods of broodiness on the two types of rations were similar. Birds fed the rations supplemented with aureomycin became broody more frequently; but the periods of broodiness were of shorter duration. As many birds on each type of ration never became broody, it is not possible to make any special interpretation of this observation.

It is concluded that the addition of aureomycin to the rations of pullets during growth and subsequent egg production is of no economic value under the conditions tested.

K. J. CARPENTER
J. DUCKWORTH

Rowett Research Institute,
Bucksburn,
Aberdeenshire.
Nov. 23.

[1] Common, R. H., Keefe, T. J., Burgess, R., and Maw, W. A., *Nature*, **166**, 992 (1950).
[2] Jukes, T. H. (private communication).
[3] Carpenter, K. J., and Duckworth, J., *J. Agric. Sci.* (in the press).

Influence of Crushing on the *p*H of Grass Silage

THE communication by de Man[1] on this subject makes desirable a brief reference to laboratory experiments here, the results of which are in the press. We have shown that with minced material the influence of added molasses on lactic acid formation is small. Pilot-scale ensilage (15-cwt. quantities) has shown, in addition, that three silages made from

chopped grass had *p*H values of 4·03, 4·00 and 4·13, while another sample of the same crop ensiled at the same time in an unchopped condition had a final *p*H of 4·46. The carbohydrates liberated by the chopping can replace molasses, and it is conceivable that, with the accompanying liberation of plant amino-acids, a further stimulus is given to the growth of lactobacilli—a possibility suggested by the findings of Dolby and Waters[2] and Harry[3] in connexion with studies on *Lactobacillus caseii*. Further, the findings of Brouwer[4], on the inter-relationship of dry matter content and *p*H in silage, mentioned by de Man, have been confirmed by Brown[5] and extended by myself[6] to include the nitrogen content as well.

A. J. Barnett

Division of Agricultural Biochemistry,
Department of Biological Chemistry,
Marischal College,
Aberdeen.

[1] de Man, J. C., *Nature*, **169**, 246 (1952).
[2] Dolby, D. E., and Waters, J. W., *Nature*, **153**, 139 (1944).
[3] Harry, E. G., *Biochem. J.*, **49**, 5 (1951).
[4] Brouwer, E., *Vers. Land. Onderz.*, **43**, 55 (1937).
[5] Brown, W. O., *J. Brit. Grassland Soc.*, **5**, 225 (1950).
[6] Barnett, A. J. G., *J. Brit. Grassland Soc.*, **5**, 93 (1950).

β-Glucuronidase Activity of Peripheral Nerve during Wallerian Degeneration

When a peripheral nerve is cut, the portion of the nerve distal to the point of section undergoes a series of changes characteristic of Wallerian degeneration. The axon and, later, the myelin sheath are destroyed and there is an increase in the number of both Schwann cells and endoneurial cells (chiefly fibrocytes and macrophages) found along the course of the nerve[1,2]. We have now shown that in such a degenerating peripheral nerve there is a marked increase in the activity of the enzyme β-glucuronidase.

The β-glucuronidase activity of the sciatic nerve of the cat increased by a factor of 30–40 sixteen days after nerve section (see table). The enzyme activity of whole homogenates of nerve was determined in acetate buffer *p*H 4·5 by the method of Fishman, Springer and Brunetti[3], using biosynthetic phenolphthalein mono-β-glucuronide as substrate.

In addition to the increase in β-glucuronidase activity, there was also an increase in the concentration of both deoxypentosenucleic acid and pentosenucleic acid. Since considerable difficulty was experienced in applying the usual methods for the quantitative determination of nucleic acids to tissue from the nervous system, resort was made to an ultra-violet absorption method[4]. The increase in the concentration of deoxypentosenucleic acid (by a factor of 3) and of pentosenucleic acid (by a factor of 4–5) is a reflexion of the well-known increase in the cellularity of the nerve. If, as has been suggested, the mean amount of deoxypentosenucleic acid per diploid cell is constant for any given species, the concentration of deoxypentosenucleic acid gives an estimate of the total number of cells in the nerve. Although cell nuclei contain small quantities of pentosenucleic acid, most of the pentosenucleic acid is in the cytoplasm. The concentration of pentosenucleic acid thus gives an indication of the total cytoplasmic mass of all the cells in the nerve, and the ratio of the concentration of pentose- to deoxypentose-nucleic acid gives an indication of the mean quantity of cytoplasm per cell. In the degenerating nerve the concentration of pentosenucleic acid increased more than the concentration of deoxypentosenucleic acid. There was thus a significant increase in the ratio of pentose- to deoxypentose-nucleic acid, suggesting an increase in the mass of cytoplasm per cell, an increase that has been observed microscopically for Schwann cells[1].

β-Glucuronidase Activity and Nucleic Acids of Cat Sciatic Nerve
(Figures in brackets represent the number of animals in each group). Mean ± Standard Error of Mean

	Normal	Degenerating 16 days	Percentage increase
β-Glucuronidase (Fishman units (see ref. 3) per 100 mgm.)	34·8 ± 1·3 (56)	1,280 ± 160 (6)	3,580
Deoxypentosenucleic acid (mgm. P per 100 gm.)	4·8 ± 0·1 (52)	14·4 ± 0·9 (6)	200
Pentosenucleic acid (mgm. P per 100 gm.)	3·9 ± 0·1 (52)	18·5 ± 0·8 (6)	370
Ratio of pentose- to deoxypentose-nucleic acid	0·81	1·29	59
β-Glucuronidase (Fishman units (see ref. 3) per μgm. deoxypentosenucleic acid P)	7·3	88·9	1,120

The great increase in β-glucuronidase activity is of interest, since Levvy, Kerr and Campbell[5] have suggested a possible relation between β-glucuronidase activity and cellular proliferation. The last line of the table indicates that in the degenerating nerve the mean β-glucuronidase activity per μgm. deoxypentosenucleic acid phosphorus, that is, the mean activity per cell, was some twelve times greater than that of the control nerve. However, in other experiments the mean β-glucuronidase activity per unit deoxypentosenucleic acid was very much less four days after nerve section, a time when cellular proliferation is at its height. Also, the β-glucuronidase activity per unit deoxypentosenucleic acid was still at the high 16-day level thirty-two days after nerve section. At this time the cellularity of the nerve, as judged by deoxypentosenucleic acid determinations, was decreasing. This would suggest, as found by Mills, Smith, Stary and Leslie[6] for rat liver regenerating after subtotal hepatectomy, that the peak in the β-glucuronidase activity per unit deoxypentosenucleic acid occurs after the phase of rapid cellular proliferation.

Similar changes were observed in the concentration of nucleic acids and β-glucuronidase activity when the nerve was crushed rather than sectioned.

This work was aided by grants from the National Research Council of Canada and the National Mental Health Grants.

D. M. Hollinger
J. E. Logan
W. A. Mannell
R. J. Rossiter

Department of Biochemistry,
University of Western Ontario,
London, Canada.
Nov. 12.

[1] Young, J. Z., *Physiol. Rev.*, **22**, 318 (1942).
[2] Abercrombie, M., and Johnson, M. L., *J. Anat., Lond.*, **80**, 37 (1946).
[3] Fishman, W. H., Springer, B., and Brunetti, R., *J. Biol. Chem.*, **173**, 449 (1948).
[4] Logan, J. E., Mannell, W. A., and Rossiter, R. J. (in the press).
[5] Levvy, G. A., Kerr, L. M. H., and Campbell, J. G., *Biochem. J.*, **42**, 462 (1948).
[6] Mills, G. T., Smith, E. E. B., Stary, B., and Leslie, I., *Biochem. J.*, **47**, xlviii (1950).

Application of Paper Chromatography to the Study of the Transaminase System

TRANSAMINASE reactions are known to occur in practically all animal tissues, especially in heart muscle, brain, kidney, liver and testes. Reactions of this type were first suggested by Needham[1], who noted that when glutamic acid was added to minced pigeon-breast muscle it disappeared without a parallel formation of ammonia. Four or five different transaminase systems have so far been thoroughly investigated by various workers[2]; but the methods employed for the study of these reactions have required manometric equipment[3] and intensive analytical procedures[4]. The present communication deals with the application of paper chromatography technique to the separation of 2 : 4 dinitrophenylhydrazones of the keto-acids in the reaction mixture, since it has proved in our hands a satisfactory tool for the study of transaminase reactions. The reaction studied was :

L-Aspartate + α-Ketoglutarate = Oxalacetate + L-Glutamate.

This reaction was allowed to proceed for different intervals in a series of small centrifuge tubes in the presence of liver enzyme, coenzyme from muscle (boiled muscle extract) and excess aspartate. α-Ketoglutarate was added in known amounts. Oxalacetic acid formed by the enzyme action was converted chemically to pyruvic acid by means of aniline citrate as described by Tonhazy, White and Umbreit[5]. Unreacted α-ketoglutarate and the resulting pyruvate were converted into their 2 : 4 dinitrophenylhydrazones. For further separation of these two compounds, partition chromatography on filter paper, as described by Cavallini, Frontali and Toschi[6], was used. A typical experiment is described below.

A normal adult rat from the stock colony was killed by stunning ; liver and muscle were dissected out and a 2 per cent liver homogenate (w/v) was prepared immediately in ice-cold phosphate buffer of *p*H 7·4. Boiled muscle extract (1 ml. equivalent to 100 mgm. of fresh muscle) was prepared in physiological saline solution. The following solutions were added to each of the six centrifuge (5-ml. capacity) tubes : 0·5 ml. buffered *M* aspartate, 0·5 ml. phosphate buffer *p*H 7·4, 0·2 ml. of boiled muscle extract and 0·1 ml. of α-ketoglutarate solution (400 μgm./ml.). The reaction mixture was brought to 37° C. in a water-bath ; 0·2 ml. of liver homogenate was then added to each tube with mixing, and the reaction allowed to proceed at 37° C. At definite intervals, the contents of one tube were treated with 0·2 ml. of 100 per cent (w/v) solution of trichloroacetic acid in order to precipitate proteins. Oxalacetate formed in the reaction mixture was converted to pyruvate by adding 0·2 c.c. of aniline citrate to each tube. Thus, the keto-acids in the tube consisted of excess unchanged α-ketoglutaric acid and pyruvic acid derived from the oxalacetic acid formed during the transaminase reaction.

The two keto acids were converted into their respective dinitrophenylhydrazones by the addition of 1 ml. of 0·2 per cent 2 : 4 dinitrophenylhydrazine in 2 *N* hydrochloric acid. The precipitated proteins were removed by centrifugation, and the excess of hydrazine and hydrazones formed were quantitatively extracted with ethyl acetate by the method of Bueding and Wortis[7]. The ethyl acetate portions were then extracted three times with 2 ml. of 10 per cent sodium carbonate solution. The combined carbonate extracts were freed from dinitrophenylhydrazine by a further extraction with 2 ml. ethyl acetate, and were acidified with concentrated hydrochloric acid to obtain free hydrazones of pyruvic and α-ketoglutaric acids. They were then transferred into 2 ml. toluene by shaking. 0·5 ml. of this material was disposed on a filter paper strip (Whatman No. 4 filter paper) and an ascending chromatogram was run for 24 hr. at 25° C. using butanol–ethanol–water (50 : 10 : 40 v/v respectively) as solvent. The strip was dried and the portions of filter paper around the spots, previously identified by their R_F values (R_F values of dinitrophenylhydrazones of pyruvic and α-ketoglutaric acids were 0·55 and 0·37 respectively), were cut into small bits and the yellow-coloured hydrazones were extracted thrice with 2 ml. of 10 per cent sodium carbonate. The red colour developed after addition of 4 ml. of 2 *N* sodium hydroxide was compared in a photoelectric colorimeter with filter 530 mμ in position. Standard curves obtained with pure samples of the dinitrophenylhydrazones of the two acids were used for reference.

The average results obtained in four experiments with normal rat liver preparations are summarized in the accompanying table.

RATE OF TRANSAMINASE REACTION

1 Time (min.)	2 α-Ketoglutarate added (μgm.)	3 α-Ketoglutarate unreacted recovered (μgm.)	4 Pyruvate recovered (μgm.)	5 α-Ketoglutarate equivalent of pyruvate formed (μgm.)	6 (3) + (5) (μgm.)	7 Recovery per cent $\frac{(6)}{(2)} \times 100$
4	40	32·4	6·1	10·2	42·6	106
8	40	26·3	7·4	12·3	38·6	97
16	40	17·6	12·9	21·4	39·0	98
20	40	9·6	19·0	31·5	41·1	103
24	40	4·9	18·8	31·2	36·1	90

It can be seen from these results that, under the conditions specified here, the velocity of the transaminase reaction in question could be conveniently followed. In 24 min., 88 per cent of α-ketoglutaric acid present in the reaction mixture was converted to oxalacetic acid. Also, good recoveries of pyruvic and α-ketoglutaric acids were obtained by adopting this procedure, and the proportionality between different quantities was very close. The technique, though somewhat time-consuming, is simple and convenient, and will be found useful in laboratories where the expensive Warburg manometric outfit is not available.

P. G. TULPULE
V. N. PATWARDHAN

Nutrition Research Laboratories,
Indian Council of Medical Research,
Coonoor.
Nov. 1.

[1] Needham, D. M., *Biochem. J.*, **24**, 208 (1930).
[2] Cohen, P. P., *J. Biol. Chem.*, **136**, 565 (1940). Cohen, P. P., and Hekhuis, G. L., *J. Biol. Chem.*, **140**, 711 (1941). Herbst, R. M., "Advance in Enzymol.", **4**, 75 (1944).
[3] Ames, S. R., and Elvehjem, C. A., *J. Biol. Chem.*, **166**, 81 (1946). Ames, S. R., Sarma, P. S., and Elvehjem, C. A., *J. Biol. Chem.*, **167**, 135 (1947).
[4] Cohen, P. P., *Biochem. J.*, **33**, 1478 (1939).
[5] Tonhazy, N. E., White, N. G., and Umbreit, W. W., *Arch. Biochem.*, **28**, 36 (1950).
[6] Cavallini, D., Frontall, N., and Toschi, G., *Nature*, **163**, 568 (1949).
[7] Bueding, E., and Wortis, H., *J. Biol. Chem.*, **133**, 585 (1940).

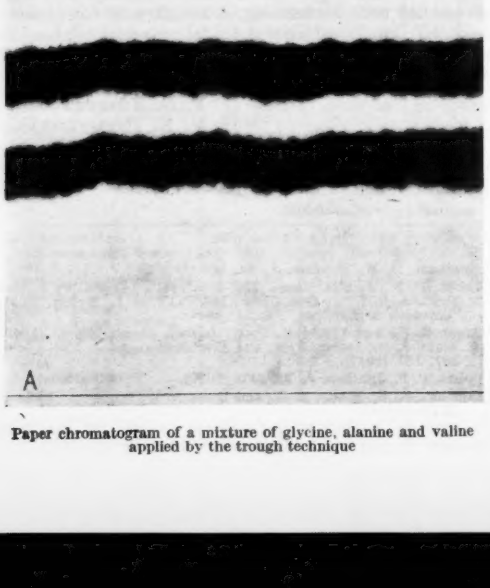
A Simple Application Technique for Paper Chromatography

Comparatively little use has been made of paper chromatography for micro or semimicro preparative purposes. A difficulty encountered in such work is that of applying relatively large quantities of material to the paper. The methods hitherto used are either time-consuming, for example, multiple, manual application of contiguous spots along a line some 24 in. in length, or require special apparatus, such as the kymograph method of Yanofsky, Wasserman and Bonner[1]. The need for a quick and simple technique of application has led to the development of the following procedure.

A line is drawn parallel to, and 2 in. from, the edge of a large sheet of filter paper. The paper is now carefully folded along the line. Dipping the edge of the fold into the solution to be chromatographed results in the application of a band of solution which is both wide and uneven. This difficulty can be avoided by bringing the edge of the paper into contact with a strip of paper wetted with the solution.

Two or three long narrow strips of filter paper, preferably hardened, are placed one on top of the other in a trough. The solution to be used is poured into the trough in quantity (*c.* 10 ml. for three strips 24 in. by ¾ in.) just sufficient to wet the strips. The chromatogram is held taut between the thumb and second finger of each hand, the index finger being used to keep the two parts of the fold apart. The edge is now brought into contact with the strips for a short period. Regulation of the contact time controls the width of the band of material taken up by the chromatogram. After drying, the process is repeated until the desired concentration has been obtained. Sheets of paper up to 18 in. in width are easily handled. 24-in. sheets are best cut in half and spotted separately.

Typical of the results obtained by this method is the chromatogram of a mixture of glycine, alanine and valine run in phenol, *A* being the starting line (see photograph).



Paper chromatogram of a mixture of glycine, alanine and valine applied by the trough technique

Thanks are due to the South African Council for Scientific and Industrial Research for permission to publish this note.

L. Novellie

National Chemical Research Laboratory,
Pretoria.
Nov. 2.

[1] Yanofsky, C., Wasserman, E., and Bonner, D. M., *Science*, 111, 61 (1950).

Bimolecular Nucleophilic Substitution with Anionotropic Rearrangement

We have been concerned to establish bimolecular substitution with rearrangement, S_N2', in anionotropic systems, for example, $EtO^- + CH_2{=}CH{-}CH(X){-}Cl \rightarrow EtO{-}CH_2{-}CH{=}CH{-}X + Cl^-$ (S_N2'). This has proved somewhat difficult, though, as it now appears, not for the reason that the mechanism is particularly uncommon, but because, in most simple cases, it is obscured by an accompanying substitution without rearrangement, S_N2. The one fully established and unambiguous case is that recently reported[1], in which an isotopic substituting agent was employed to destroy the power of a faster S_N2 substitution to mask a slower S_N2' reaction. This work confirmed a suggestion, which had been made on theoretical grounds earlier[2], that what was needed to make S_N2' substitution observable without any necessity for such special measures was a suitable α-substituent in the allyl system, in order to retard selectively the S_N2 process.

On examining the literature, we noticed records to the effect that 1-chloro-3-ethoxypropene-1 had been isolated from the products of reaction of 3,3-dichloropropene-1 with sodium ethoxide[3], and that the total process had been shown to have approximate second-order kinetics[4,5]. Certainly, the fact that only part of the original chlorine is displaced in the reaction supports rearrangement, since substitution without rearrangement would produce an α-chloro-ether, which would readily lose its chlorine. This suggests that an α-chloro-substituent in an allyl halide system is, as might be supposed on other grounds, competent to favour the S_N2' reaction sufficiently to render it easily observable. (A halogen atom at the site of substitution inhibits mechanism S_N2; for example, for the reaction with Br^- at 25°, $k_{CH_3Br}/k_{CH_2Br_2} = 3{,}800$.)

We have therefore re-examined the products and kinetics of the reaction between 3,3-dichloropropene-1 and sodium ethoxide, and have established the following points:

(1) Substitution with rearrangement occurs concurrently with substitution without rearrangement, the rates of the two processes being of the same order of magnitude.

(2) *trans*-1-Chloro-3-ethoxypropene-1 is formed in considerable yields (for example, 25 per cent at 85°). The *cis*-isomer of this product is also obtained, but it participates more readily in further changes. From reactions which were discontinued before reaching their final stages, the dihalide was isolated unchanged.

(3) The production of 1-chloro-3-ethoxypropene-1 has the kinetic form $v = k_2[R.CHCl_2][OEt]$. Solvolysis of the dihalide is negligible by comparison with this second-order reaction.

We conclude that mechanism S_N2' is operative in this change. Other reactions of 3,3-dichloropropene-1 are being investigated similarly.

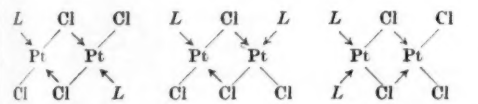
P. B. D. de la Mare
E. D. Hughes
C. A. Vernon

University College,
London, W.C.1.
Nov. 28.

[1] England, B. D., and Hughes, E. D., *Nature*, **168**, 1062 (1951).
[2] Catchpole, A. G., Hughes, E. D., and Ingold, C. K., *J. Chem. Soc.*, 8 (1948).
[3] See, especially, Kirrmann, A., Pacaud, and Dosque, H., *Bull. Soc. Chim.*, [v], **1**, 860 (1934).
[4] Andrews, L. J., and Kepner, R. E., *J. Amer. Chem. Soc.*, **70**, 3456 (1948).
[5] Smith, H. A., and King, W. H., *J. Amer. Chem. Soc.*, **72**, 95 (1950).

Isomerism of Planar Binuclear Co-ordination Complexes

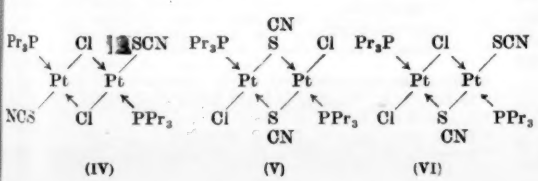
When Pfeiffer[1], in 1923, suggested that in complex compounds of the type $(LMCl_2)_2$ (L = non-ionic ligand; M = divalent metal, for example, Pt[II]), the metal atoms were 'bridged' by halogen atoms as in (I), he also pointed out the possible existence of isomers (II) and (III); but no proved case of such isomerism has yet been reported in any series of bridged complexes, whether the metal atoms show a tetrahedral or planar co-ordination.



(I) (II) (III)

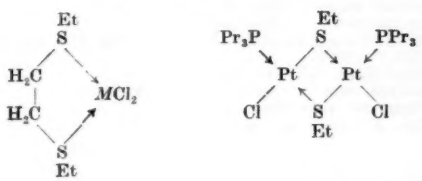
Because platinum[II] forms the most stereochemically rigid planar complexes of the type L_2PtCl_2, and numerous cases of *cis*- and *trans*-isomers are known in this series, it seemed probable that geometrical isomerism among planar bridged complexes would also be found in the platinous series. It is very improbable that complexes of configuration (III) will exist, because of the large separation of electric charge involved in their formation. Attempts to prepare a palladous complex, which must of necessity have this configuration, by employing a ditertiary arsine as chelating ligand, were unsuccessful[2], although monotertiary arsines readily form bridged complexes which in the crystal have the structure type (I)[3,4]. We[5] have also examined the tri-*n*-propylphosphine bridged complex with platinous chloride, but find no evidence of isomerism. It is isomorphous with the corresponding palladium complex, so has structure (I) ($L = (n\text{-}C_3H_7)_3P$).

In the palladium series, it has been demonstrated that sulphur bridges are more stable than chlorine bridges[6]; thus it seemed worth while examining some sulphur-bridged platinous complexes for geometrical isomerism. We accordingly prepared complexes of the composition $(Pr_3P)_2Pt_2Cl_2(SCN)_2$ (*a*) and $(Pr_3P)_2Pt_2Cl_2(SEt)_2$ (*b*) ($Pr = n\text{-}C_3H_7$; $Et = C_2H_5$) by allowing the chlorine-bridged complex $(Pr_3P)_2Pt_2Cl_4$ to react with two molecular proportions of potassium thiocyanate and with an excess of ethylmercaptan respectively. We have, in the compounds (*a*) and (*b*), the possibility of both structural and geometrical isomerism which we shall illustrate by reference to the dithiocyanate. (IV) and (V) are possible structural isomers of type (I), whereas (VI) is a less probable structural isomer. Also, because the three bonds from the sulphur atoms are not planar, (V) can show geometrical isomerism according to whether the CN groups are in *cis* or *trans* relationship to each other; these we shall refer to as *cis*- and *trans*-(V) respectively. Thus, if we ignore the very improbable structures based on type (III), we have four isomers based on type (I) and a similar four based on type (II), making eight possible isomers for each of the compounds (*a*) and (*b*).



(IV) (V) (VI)

We have separated our preparations of (*a*) and (*b*), each into two isomeric compounds designated α and β (see table). Their dipole moments show unambiguously that the α- and β-dithiocyanates are structural isomers, whereas the α- and β-dimercapto compounds are geometrical isomers of types (I) and (II). Thus we have the first example of structural isomerism among planar bridged complexes and the only proved example of a compound of type (II). We found no evidence of stable isomers due to the possibility that the CN or Et radical may be in *cis* or *trans* relationship to each other across the Pt_2S_2 ring, but this was not unexpected, because Bennett, Mosses and Statham[7] failed in their search for such isomerism in the chelate complexes of type (VII), employing a variety of divalent metals M.



(VII) (VIII)

The structures have been assigned on the following basis.

(*a*) The α- and β-isomers have small dipole moments so both are of type (I). *Cis*-(V) would have a dipole moment of about 5 D., so the α- and β-isomers are structural isomers, most probably (IV) and (V). This is in accord with the further reaction of potassium thiocyanate, which yields from each isomer the same tetrathiocyanate $(Pr_3P)_2Pt_2(SCN)_4$. Here, geometrical isomerism but not structural isomerism is possible. That we found no isomerism is further evidence that the isomerism of the dithiocyanate is structural. As we know that sulphur bridges are more stable than chlorine bridges, the labile α-isomer has been assigned the halogen-bridged structure (IV) and

Properties	(a) $(Pr_3P)_2Pt_2Cl_2(SCN)_2$		(b) $(Pr_3P)_2Pt_2Cl_2(SEt)_2$	
	α	β	α	β
Melting point °C.	144–152	173–174·5	125·5–127	156·5–157·5
Colour	yellow	pale yellow	yellow	v. pale yellow
Stability	labile	stable	stable	stable
Dipole moment (Debye units)	1·57	1·36	10·35	~0
Probable structures	IV	V	VIII	Corresponding to V

Dipole moments were calculated assuming $P_A = 18$ per cent P_E[4]

the stable β-isomer structure (V). The moment of 1·36 D. observed for (V) suggests that this isomer exists in solution as an equilibrium mixture of *cis*- and *trans*-(V). This conclusion is uncertain, however, because $(Pr_3P)_2Pt_2Cl_4$, which is known to have a symmetrical structure in the solid state[5], has a moment of 1·6 D. in benzene solution (cf. the moments of the corresponding palladium compounds[3]).

(*b*) Evidence similar to that adduced for the position of the SEt in the similar palladium compounds[6] shows that the SEt group must be in the bridge in both isomers. The α-isomer of zero moment must be the symmetrical type (I) isomer, corresponding to (V). A moment of about 10 D. would be expected for the type (II) complexes. The structure of the β-isomer must therefore be (VIII), in which the Et groups are probably in *trans* configuration about the Pt_2S_2 ring.

Full details of this isomerism will be published elsewhere.

J. Chatt
F. A. Hart

Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
"The Frythe",
Welwyn, Herts.
Nov. 30.

[1] "Anorganische Chemie", 56, 170.
[2] Chatt and Mann, *J. Chem. Soc.*, 1622 (1939).
[3] Mann and Purdie, *J. Chem. Soc.*, 873 (1936).
[4] Mann and Wells, *J. Chem. Soc.*, 702 (1938). Wells, *Proc. Roy. Soc.*, A, **167**, 169 (1938).
[5] Chatt, *J. Chem. Soc.*, 652 (1951).
[6] Chatt and Mann, *J. Chem. Soc.*, 1949 (1938).
[7] *J. Chem. Soc.*, 1668 (1930).
[8] Jensen, *Z. anorg. Chem.*, **229**, 225 (1936).

Minimum Infiltration-Rates to Underground of Rain water in South Africa

In a previous communication I have discussed the importance of the determination of the infiltration-rate to underground of rain-water. I also indicated the difficulties to be overcome in the determination of this element of hydrology[1].

Using the du Toit method, I have now calculated the minimum infiltration-rates of the average annual rainfall, to underground, for certain catchment areas (Table 1). The values are of the same order (11 per cent) as those quoted by du Toit for the dolomite near Johannesburg[2].

The first four catchment areas of Table 1 are all in the Transvaal; they have a summer rainfall and are in rolling dolomite country. The dolomite is highly cavernous, and in many places small underground lakes can be mapped, notably at Sterkfontein, the site of many prehistoric human or humanoid remains. The Halseton catchment is in very rocky dolerite mountainous country, with rains rather late in the summer.

Table 1

Catchment area	Average annual rainfall (in.)	Pumpage (acre-feet per square mile per annum)	Proportion of total average annual precipitation (%)
Olifantsfontein	25	88	6·5
Olifantsfontein	25	111	8·2
Zuurbekom	27	59	4·0
Maloney's Eye	26	140	10·0
Halseton	26	28	2·4

Detailed mapping and geophysical field work has been carried out in each of these areas, and the pumpage or spring flow is fairly accurately known. From various results it is known that not all the underground water is recovered, and hence it is considered that these figures are to be regarded as a minimum value, rather than as an average.

It is interesting to note that rather higher values have been obtained in the United Kingdom, using the same method of calculation[3].

In the United States the values are rather nearer the United Kingdom values than those of the Union of South Africa[4]. It is probable, therefore, that the extraction in our not completely developed water schemes is only a fraction of the total underground flow. Using data from various sources, I have calculated the water balances for the Okavango Delta and Linyanti Swamps (Table 2).

Table 2. Water Balances of Okavango Delta and Linyanti Swamps
(All quantities in acre-feet per annum)

Element	Okavango Delta (swamps only)	Okavango Delta plus Lake Ngami	Linyanti Swamps
Total river flow	10,000,000	10,000,000	3,000,000
Precipitation at 18 in. per annum over evaporation area	4,400,000	4,600,000	520,000
	14,400,000	14,600,000	3,520,000
Net evaporation at 60 in. per annum	14,800,000	15,000,000	1,735,000
Infiltration to underground	Nil	Nil	1,785,000

Both the evaporation areas are closed drainages, and hence can be considered as gigantic lysimeters. MacKenzie calculates the total evaporation loss in the Okavango Delta at 72 in. per annum over 3,000 square miles, giving a total of 11,448,000 acre-feet per annum[5]. This would mean an infiltration-rate to underground of 2,952,000 acre-feet, or about 20 per cent of the total annual water in the swamps. MacKenzie considers that the entire flow of the Linyanti is dissipated by evaporation.

V. L. Bosazza

Petrologgia,
39 Barkly Road,
Parktown,
Johannesburg.
Nov. 11.

[1] *Nature*, **166**, 344 (1950).
[2] du Toit, A. L., "Geology of South Africa", 486 (1939).
[3] *J. Inst. Water Eng.*, **2**, 97 (1948).
[4] *Trans. Amer. Soc. Civ. Eng.*, **2**, 97 (1948).
[5] Report Kalahari Expedition, 1945 (Irrigation Dept., Union of South Africa).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, April 19

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Prof. E. L. J. Potts: "A Study of Air Flow in Fan Drifts".

Sunday, April 20

INTERNATIONAL HÆMOPHILIA SOCIETY (in the small Assembly Room, St. Pancras Town Hall, London, W.C.1), at 2 p.m.—Annual General Meeting.

Monday, April 21

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Sir John Hacking: Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—M. Herzog and M. de Noyelle: "The Conquest of Annapurna".

Tuesday, April 22

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. C. Klepp: "Recent Developments in Instruments".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. E. Ward: "An Analogue Computer for Use in the Design of Servo Systems"; Mr. F. J. U. Ritson and Mr. P. H. Hammond: "The Design and Testing of an Electronic Servo-Simulator for a Hydraulic Remote Position-Controller".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Harold E. Wild: "Samöens in Savoy—Maytime in the French Alps".

Tuesday, April 22—Friday, April 25

ROYAL SANITARY INSTITUTE (at the Winter Gardens, Margate).—Health Congress.

Wednesday, April 23

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting; Sir Charles Normand: "Atmospheric Ozone and the Upper-Air Conditions" (Presidential Address).

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. G. E. Foxwell: "Fuel Technology and Civilization" (Presidential Address).*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. F. Roberts: "The Flying Spot Microscope".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Dr. V. L. S. Charley: "Soft Drinks and Fruit Juices—with Comments on their Nutritional Value".

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. F. A. Paneth, F.R.S.: "The Chemical Exploration of the Stratosphere" (Hugo Müller Lecture).

Thursday, April 24

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Henry Jarvis Hall, Royal Institute of British Architects, 66 Portland Place, London, W.1), at 4 p.m.—Fifth Annual General Meeting; at 5 p.m.—Prof. Erwin Meyer: "Recent Investigations in Architectural Acoustics and Electro-Acoustics".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Symposium on "Form and Function" (to be opened by Prof. Alastair Graham, Dr. V. Fretter, Dr. J. E. Forrest, Mr. B. B. Boycott and Mr. J. E. Morton).

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. S. M. Blair: "The Oil Industry in Alberta" (Neil Matheson McWharrie Lecture).

BRITISH GLACIOLOGICAL SOCIETY (in the New Laboratory, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. Maynard M. Miller: "Glacial Studies in the Lago Argentino District of Patagonia".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Charles Goodeve, F.R.S.: "Iron Atoms in the Service of the Electrical Engineer" (Forty-third Kelvin Lecture).

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. J. C. Fidler: "Some Effects of Low Temperatures on Biological Systems".

INSTITUTE OF PETROLEUM (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. C. A. P. Southwell: "Kuwait" (Presidential Address).

Thursday, April 24—Saturday, April 26

INSTITUTE OF WELDING (at Glasgow).—Spring Meeting.

Thursday, April 24—Sunday, April 27

SOUTH EASTERN UNION OF SCIENTIFIC SOCIETIES (at the Devonshire Park Pavilion, Eastbourne).—Fifty-seventh Annual Congress.

Friday, April 25

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, in the Winter Gardens, Margate), at 9.30 a.m.—Discussion on "Bacteriological Standards for Perishable Foods" (to be opened by Prof. H. D. Kay).

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 12 noon.—Sir Harold Hartley, F.R.S.: "Chemical Engineering at the Cross Roads" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion (Papers Meeting) (Speakers: Dr. W. Bullerwell, Dr. E. C. Bullard, F.R.S., Prof. Harold Jeffreys, F.R.S., Dr. E. R. R. Holmberg).

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Papers on "Impressions of Spectroscopy in the United States".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INTERNAL COMBUSTION ENGINE and STEAM GROUPS, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. John Lamb: "Explosions in Enclosed Crank-cases of Steam and Internal Combustion Engines—their Cause, Effect and Possible Remedy".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Transients and the Use of Operational Methods" (to be opened by Instr.-Comdr. D. K. McCleery and Dr. H. Tropper).

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Dr. A. Theile: "Colour Television".

WOLVERHAMPTON SOCIETY OF APPLIED SCIENCE (at the Technical College, Wolverhampton), at 7.30 p.m.—Mr. H. V. Shaw: "Earthquakes and How they are Recorded".

Saturday, April 26

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, NORTH OF ENGLAND SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. R. Belcher: "Some New Methods in Analytical Chemistry".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. R. H. Thouless: "The Formal Aspects of the Problem of National Psychological Differences".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD (Principal Scientific Officer grade) OF THE INSTRUMENTATION DEPARTMENT—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (April 26).

LECTURER (Grade I or II) IN PHARMACEUTICAL CHEMISTRY, and a LECTURER (Grade I or II) IN PHARMACOGNOSY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (April 26).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (April 26).

ASSISTANT (Grade B) IN BIOLOGY in the Chemistry and Biology Department—The Registrar, Technical College, Sunderland (April 29).

ASSISTANT LECTURER or LECTURER IN APPLIED MATHEMATICS, and a LECTURER IN PURE MATHEMATICS (to specialize in the teaching of mathematics to engineering students)—The Secretary, Queen's University, Belfast (April 30).

LECTURER IN MATHEMATICS—The Secretary, The University, 38 North Bailey, Durham (April 30).

NUFFIELD RESEARCH FELLOWSHIP IN BIOCHEMISTRY in the Wheatstone Physics Laboratory—Prof. J. T. Randall, F.R.S., Department of Physics, King's College, Strand, London, W.C.2 (April 30).

NUFFIELD RESEARCH FELLOWSHIP IN PHYSICAL CHEMISTRY in the Wheatstone Physics Laboratory—Prof. J. T. Randall, F.R.S., Department of Physics, King's College, Strand, London, W.C.2 (April 30).

PROFESSOR OF MECHANICAL ENGINEERING, and a PROFESSOR OF PHYSICS, at Birla Colleges, Pilani, India—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1 (April 30).

RESEARCH FELLOW and SENIOR RESEARCH FELLOW IN THE DEPARTMENT OF PHYSIOLOGY in the John Curtin School of Medical Research—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (May 2).

BIOCHEMISTS or BIOLOGISTS (with a first- or second-class honours degree or equivalent qualification) in the Ministry of Agriculture and Fisheries, to work in a team engaged in the study of the mineral metabolism of fish and other marine animals—The Ministry of Labour and National Service, Technical and Scientific Register, Almack House, 26 King Street, London, S.W.1, quoting G.67/52A (May 3).

LECTURER IN BACTERIOLOGY in the Department of Agricultural Sciences at the School of Agriculture—The Registrar, The University, Nottingham (May 3).

PHYSICISTS AND ELECTRICAL ENGINEERS (Scientific Officer grade) (with a first- or second-class honours degree in physics or electrical engineering or equivalent qualification) at an R.A.F. Signals Experimental Establishment in Norfolk—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.380/51A (May 3).

Chair of Biochemistry at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

Head of the Department of Physiology—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 5).

Assistant Lecturer in the Department of Geology, with special qualifications in Palæontology—The Registrar, University College, Cathays Park, Cardiff (May 10).

Assistant Lecturer in Inorganic and Physical Chemistry—The Registrar, The University, Nottingham (May 10).

Lecturer in Pharmacology within the Department of Pharmacology and Therapeutics in the Medical School, Dundee—The Secretary, The University, St. Andrews (May 15).

Tutorial Research Studentships in Mathematics (pure or applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (May 19).

Lecturer in Civil Engineering at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

Senior Lecturer in Agricultural Chemistry—The Secretary of University Court, The University, Glasgow (May 31).

Walter Mersh Steong Research Fellowship (University of Sydney) for original research in Papua in any of the biological, physical or social sciences related to Papua or in Papuan history or linguistics—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

Harry Ferguson Scholarships in Agricultural Engineering—The Registrar, King's College Newcastle-upon-Tyne (July 15).

Assistant Divisional Engineers (one at Oxford and one at Reading)—The Chief Engineer, Thames Conservancy, De Bohun Road, Reading.

Assistant Lecturer, Grade B (honours graduate in inorganic and/or physical chemistry) in the Department of Chemistry—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Electrical Engineers (temporary) in the Electrical Engineering Department of the Admiralty—The Ministry of Labour and National Service, Technical and Scientific Register, Almack House, 26 King Street, London, S.W.1 (for transmission to the Admiralty, Bath).

Executive Engineers (Mechanical), and Mechanical Engineers, in the Mechanical Engineering Division of the Snowy Mountains Hydro-Electric Authority, Australia—The Engineer-in-Charge, S.M.H.E.A., 18 St. George Street, London, W.1.

Experimental Officer at a Royal Ordnance Factory in Somerset, for work connected with the manufacture of explosives and acids and routine analysis of a more intricate nature—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.211/52A.

Head of the Department of Hop Research—The Registrar, Wye College, Wye, Ashford, Kent.

Research Scholarships tenable in the Department of Chemistry, Colour Chemistry and Dyeing and/or other Departments—The Principal, Technical College, Dept. A, Queen Street South, Huddersfield.

Statistician (with a good honours degree in mathematics and some research experience in statistics, preferably in a biological field of application) to assist in the design and analysis of experimental work and to carry out research on problems arising out of the work of the station—The Secretary, Grassland Research Station, Drayton, Stratford-on-Avon.

Visiting Lecturer in Psychology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Thirty-first Annual Report, October 1st, 1950, to September 30th, 1951. Pp. 154. (Leatherhead: British Electrical and Allied Industries Research Association, 1952.) [72

Design and Research Centre for the Gold, Silver and Jewellery Industries. Annual Report for the Year 1950–1951. Pp. 12. (London: Goldsmiths' Hall, 1952.) [72

Library Association. Pamphlet No. 9: County Library Transport; a Report of the Transport Sub-Committee of the County Libraries Section. Edited by F. A. Sharr. Pp. 64. 7*s*.; to Members, 5*s*. Pamphlet No. 10: The State as Publisher; a Librarian's Guide to the Publications of His Majesty's Stationery Office. By Sidney Horrocks. Pp. 32. 5*s*.; to Members, 3*s*. 6*d*. (London: Library Association, 1952.) [122

Technology and History. By Charles Singer. (L. T. Hobhouse Memorial Trust Lecture No. 21, delivered on 23 October 1951 at the London School of Economics and Political Science.) Pp. 19. (London: Oxford University Press, 1952.) 2*s*. net. [122

Bulletin of the British Museum (Natural History). Entomology, Vol. 2, No. 4: A Collection of Fleas from the Bodies of British Birds, with Notes on their Distribution and Host Preferences. By Miriam Rothschild. Pp. 185–232. (London: British Museum (Natural History), 1952.) 10*s*. [122

National Research Development Corporation. Report and Statement of Accounts for the Year 1st July 1950 to 30th June 1951. Pp. 18. (London: H.M. Stationery Office, 1952.) 9*d*. net. [132

Bulletin of Mechanical Engineering Education. No. 1, January. Pp. 48. (Manchester: Municipal College of Technology, 1952.) [132

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 13: The General Principles of Smoke-Curing of Fish. By Dr. C. L. Cutting. Pp. 16. (London: H.M. Stationery Office, 1951.) 9*d*. net. [132

Flora of Tropical East Africa. Editors: Dr. W. B. Turrill and E. Milne-Redhead. Foreword and Preface. Pp. xii. Ranunculaceæ. By E. Milne-Redhead and Dr. W. B. Turrill. Pp. 24. (London: Crown Agents for the Colonies, 1952.) [132

Proceedings of the Royal Society of Edinburgh, Section A (Mathematical and Physical Sciences). Vol. 63, Part 3, No. 14: Experiments in Diffraction Microscopy. By Dr. G. L. Rogers. Pp. 193–221 + 2 plates. 6*s*. Vol. 63, Part 3, No. 15: Theorems on the Convergence and Asymptotic Validity of Abel's Series. By A. J. Macintyre and Sheila Scott Macintyre. Pp. 222–231. 1*s*. 9*d*. Vol. 63, Part 3, No. 16: Some Continuant Determinants arising in Physics and Chemistry, 2. By Dr. D. E. Rutherford. Pp. 232–241. 1*s*. 9*d*. Vol. 63, Part 3, No. 17: The Sargent Diagram for the Electron-capture Process, and the Distribution Integration Energies of Heavy β-Emitters. By N. Feather. Pp. 242–256. 2*s*. 6*d*. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [132

Other Countries

Queen Victoria Memorial, Salisbury, S. Rhodesia. Annual Report for the Year ended 31st March 1951. Pp. 16. (Salisbury: Queen Victoria Memorial, 1951.) [132

Meddelanden från Oceanografiska Institutet i Göteborg. 18: On the Sequence of Deposits in the Equatorial Atlantic Ocean. By Wolfgang Schott. Pp. 16. 19: Tertiary Radiolaria in Western Pacific Sediments. By W. R. Riedel; with a Note by Hans Pettersson on Current Observations close to the Ocean Bottom. Pp. 22 + 2 plates. (Göteborg: Elanders Boktryckeri A.-B., 1952.) [132

Reports of the Swedish Deep-Sea Expedition. Vol. 2: Zoology, No. 2: On the Shape and the Length of the Cable during a Deep-Sea Trawling. By B. Kullenberg. Pp. 29–44. (Göteborg: Elanders Boktryckeri A.-B., 1951.) [132

Répertoire des Bibliothèques de France. Tome 3: Centres et Services de Documentation. Édité par l'Organisation des Nations Unies pour l'Éducation la Science et la Culture et la direction des Services des Bibliothèques de France. Pp. iii + 288. (Paris: Bibliothèque Nationale, 1951.) 450 francs. [132

Organisation Européenne pour la Protection des Plantes. Rapport du Groupe de Travail sur les mesures de Contrôle Phytosanitaire. Pp. 16. Rapport du Groupe de Travail désigné pour étudier le danger que constituent pour les pays européens, les parasites et maladies qui peuvent y être introduits et pour recommander les mesures préventives appropriées. Pp. 11. (Paris: Organisation Européenne pour la Protection des Plantes, 1951.) [132

Harvard Meteorological Studies. No. 9: The Climate of Blue Hill according to Air Masses and Winds. By Photios P. Karapiperis. (Published for Blue Hill Meteorological Observatory.) Pp. 105. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1951.) 8*s*. net. [132

United States Department of the Interior: Geological Survey. Bulletin 955–F: Quicksilver Deposits of the Bonanza—Nonpareil District, Douglas County, Oregon. By R. E. Brown and A. C. Waters. (Contributions to Economic Geology, 1947.) Pp. iv + 225–251 + plates 29–38. n.p. Bulletin 969–E: Quicksilver Deposits of the Horse Heaven Mining District, Oregon. By A. C. Waters, Randall E. Brown, Robert R. Compton, Lloyd W. Staples, George W. Walker and Howel Williams. (Contributions to Economic Geology, 1949–50.) Pp. iv + 105–149 + plates 20–37. n.p. Bulletin 973–A: Magnetic Exploration for Chromite. By H. E. Hawkes. (Contributions to Economic Geology, 1951.) Pp. iv + 21. 15 cents. Bulletin 977: Bibliography of North American Geology, 1949. By Emma Mertins Thom, Marjorie Hooker and Ruth Reece Dunaven. Pp. iii + 273. 55 cents. Bulletin 978–A: Magnesium-Mineral Resources of the Currant Creek District, Nevada. By Charles J. Vitaliano. (Contributions to Economic Geology, 1951.) Pp. iv + 25 + 8 plates. 70 cents. Bulletin 981–A: Geophysical Abstracts 144, January–March 1951 (Numbers 12514–12700). By Mary C. Rabbitt and S. T. Vesselowsky. Pp. iii + 54. 25 cents. (Washington, D.C.: Government Printing Office, 1951.) [132

United States Department of the Interior: Geological Survey. Professional Paper 223: Geology and Ore Deposits of the Front Range, Colorado. By T. S. Lovering and E. N. Goddard. Pp. ix + 319 + 30 plates. (Washington, D.C.: Government Printing Office, 1950.) [132

United States Department of the Interior: Geological Survey. Water-Supply Paper 1096: Water Levels and Artesian Pressure in Observation Wells in the United States in 1947, Part 1, Northeastern States. Pp. vi + 470. 1 dollar. Water-Supply Paper 1097: Water Levels and Artesian Pressure in Observation Wells in the United States in 1947, Part 2, Southeastern States. Pp. vi + 270. 60 cents. Water-Supply Paper 1098: Water Levels and Artesian Pressure in Observation Wells in the United States in 1947, Part 3, North-Central States. Pp. vi + 351. 75 cents. Water-Supply Paper 1100: Water Levels and Artesian Pressure in Observation Wells in the United States in 1947, Part 5, Northwestern States. Pp. v + 183. n.p. Water-Supply Paper 1101: Water Levels and Artesian Pressure in Observation Wells in the United States in 1947, Part 6, Southwestern States and Territory of Hawaii. Pp. vi + 316. 70 cents. Water-Supply Paper 1112: Surface Water Supply of the United States, 1948, Part 2, South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. xi + 554. n.p. Water-Supply Paper 1116: Surface Water Supply of the United States, 1948, Part 6, Missouri River Basin. Pp. xiii + 703. 1.75 dollars. Water-Supply Paper 1122: Surface Water Supply of the United States, 1948, Part 12, Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. ix + 364. 1 dollar. Water-Supply Paper 1127: Water Levels and Artesian Pressure in Observation Wells in the United States in 1948, Part 2, Southeastern States. Pp. vi + 240. 55 cents. Water-Supply Paper 1149: Surface Water Supply of the United States, 1949, Part 9, Colorado River Basin. Pp. x + 429. 1 dollar. (Washington, D.C.: Government Printing Office, 1951.) [132

Canada: Department of Mines and Technical Surveys, Mines Branch. Memorandum Series No. 116: The Utilization of Low Grade Domestic Chromite. By K. W. Downes and D. W. Morgan. Pp. iv + 54. (Ottawa: King's Printer, 1951.) [132

Union of South Africa: Department of Mines. Geological Survey Memoir No. 44: The Diamondiferous Gravels of Lichtenburg. By Dr. Alex. L. du Toit. Pp. iv + 50. (Pretoria: Government Printer, 1951.) 5*s*. [132